<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>4365</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>This chapter should emphasize the need for data sharing and data collection at finer spatial and temporal aspects. [Shoussert, Roy, United States of America]</td>
<td>Noted. This is addressed in section 4.4.2 in the SDG.</td>
</tr>
<tr>
<td>4878</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Consider to include a &quot;box&quot; on enabling CCS and BECCS. The IEA CCS Unit, GCCSI and other CCS actors can help with delivery of content. [Valentina Bosetti, Italy]</td>
<td>Noted. A version of this will be included in the SDG.</td>
</tr>
<tr>
<td>1304</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>General comment on the whole chapter: I would be useful to have a table or graphic for policy makers and practitioners which highlights the most significant opportunities for adaptation and transformation in the move to a 1.5 degree world, together with the key barriers to implementation and the synergies related to these. [Delma Roberts, South Africa]</td>
<td>Rejected. Please refer to section 4.1.</td>
</tr>
<tr>
<td>3811</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.2.2.1 Why is this section needed as a whole chapter discusses this? [Valentina Bosetti, Italy]</td>
<td>Noted.</td>
</tr>
<tr>
<td>12315</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.2.2.2 Why is this section needed as a whole chapter discusses this? [Valentina Bosetti, Italy]</td>
<td>Noted.</td>
</tr>
<tr>
<td>3812</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(With regard to 3.6.2) I would be good to know what is this chapter about, as the executive summary read as the executive summary of the whole report. What is this chapter supposed to cover? [Valentina Bosetti, Italy]</td>
<td>Noted.</td>
</tr>
<tr>
<td>9904</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Some parts of this chapter is not yet ready for review. To judge feasibility of response measures needs solid input from Chapter 2 and 3. Still many descriptions are too general, lengthy and not so sharply targeting to 1.5 issue. Volume needs to be decreased. [Shoussert, Nishioka, Japan]</td>
<td>Accepted. Links between the chapters are improved and the text has been revised and sharpened.</td>
</tr>
<tr>
<td>11040</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>In general discussion on the political dimension is underdeveloped, particularly when it comes to the political economy or the politics of climate policy measures [Kevin Garden, Germany]</td>
<td>Accepted. We have tried to increase this part in section 4.4.</td>
</tr>
<tr>
<td>4858</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The chapter contains many references to grey literature. According to IPCC discussion after AR4 the grey literature has to be (or should be) labelled in 4.2.2.2 same as above [Valentina Bosetti, Italy]</td>
<td>Noted. The section on SLCPs is based on the options, and does not discuss the policy responses.</td>
</tr>
<tr>
<td>7985</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>What about public acceptance of: genetic technologies?, of underground reservoirs for CO2?, of SRM?, of SAI?, of MCB? Why should these technologies be more acceptable than nuclear? [Shoussert, Szezynski, B., et al. (2013) cited, the text have been revised.</td>
<td></td>
</tr>
<tr>
<td>7224</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The executive summary analyses acceptor behavior but does not include an analysis on the effect of the political cycles (4-5 elections followed by new governments) in achieving the long term targets. Policymakers tend to focus on aspects relevant during their short term in office and this should be pointed out given its relevance to achieve the 1.5 degree target. (Carlos Garcia Soto, Spain)</td>
<td>Noted. No literature provided.</td>
</tr>
<tr>
<td>20799</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>How come there is no mention of the Climate and Clean Air Coalition (CCAC) which has been set up as the only international response to address SLCPs? It after all covers over 50 countries as partners as well as many NGOs, NGOs and research groups [Valentina Bosetti, Italy]</td>
<td>Noted. The section on SLCPs is based on the options, and does not discuss the policy responses.</td>
</tr>
<tr>
<td>9957</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Some parts of this chapter is not yet ready for review. To judge feasibility of response measures needs solid input from Chapter 2 and 3. Still many descriptions are too general, lengthy and not so sharply targeting to 1.5 issue. Volume needs to be decreased. [Shoussert, Nishioka, Japan]</td>
<td>Accepted. Links between the chapters are improved and the text has been revised and sharpened.</td>
</tr>
<tr>
<td>14025</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>While I strongly agree to the inclusion of Box 4.13 on SRM, the positioning of the box and the explanation for its inclusion are one of the most important issues for SRM. It is important that it be made clear that SRM cannot be used as a mitigation option. There is now a considerable reduction in the level of ambition, partly in line with the sixth conference of parties in 2015. But it is also important to state explicitly that SRM cannot be used as an option for mitigation. I strongly suggest that the text be changed to include the section on &quot;mitigation, adaptation, and SRM&quot; as &quot;peak shaving&quot;) scenarios.</td>
<td>Revised. Box was rewritten to be more related to 1.5C and to make more clear the status of SRM.</td>
</tr>
<tr>
<td>20573</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.2.5.6: Would be relevant to add a bit more on this area. Thinking of my scientific field (Psychology) and also thinking of the fact that the Paris agreement will need to be implemented, it is important to use all potential tools/knowledge on human behavior. Psychology is an area of science that targets behavior. In this area there has been some key research conducted on behaviour change and maintenance as well as on implementation (e.g. of guidelines by health care professionals). Psychology can contribute with key knowledge on behavior change theories (many of which rely on key interactions between the person and its context and acknowledge that humans are not rational decision making machines) in order to allow the development of better behavioral action plans and coping plans. [Shoussert, Szezynski, B., et al. (2013) cited, the text have been revised.</td>
<td></td>
</tr>
<tr>
<td>9994</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Some parts of this chapter is not yet ready for review. To judge feasibility of response measures needs solid input from Chapter 2 and 3. Still many descriptions are too general, lengthy and not so sharply targeting to 1.5 issue. Volume needs to be decreased. [Shoussert, Nishioka, Japan]</td>
<td>Accepted. Links between the chapters are improved and the text has been revised and sharpened.</td>
</tr>
</tbody>
</table>
IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4

<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>10358</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The are incongruities in the use of the term Afforestation and Reforestation. In some sections only afforestation is used when in fact it refers to both, while in others both terms are used. [Marti Jose Sanchez, Spain]</td>
<td>Accepted. Inconsistencies are addressed and the terms are both included in the Glossary.</td>
</tr>
<tr>
<td>10359</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Despite the apparent disadvantages of A/R and that they should not be used to substitute efforts in other sectors. Those are measures that could be key in certain regions and can alleviate pressure on natural forest. [Marti Jose Sanchez, Spain]</td>
<td>Noted. Prescriptive language cannot be adopted but the benefits of A/R options for other problems are acknowledged in section 4.3.3 and in chapter 5.</td>
</tr>
<tr>
<td>20853</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>How come there is no mention of the Climate and Clean Air Coalition (CCAC) which has been set up as the only international response to address SLCPs? Not all countries over 50 countries as partners as well as many NGOs, research institutes. Johan Carl Brunnels, United Kingdom (of Great Britain and Northern Ireland)</td>
<td>Noted. The section on SCPCs is based on the options, and does not discuss the policy responses Not aware of peer-reviewed literature assessing this?</td>
</tr>
<tr>
<td>1405</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Chapter 2 has basically said that hitting 1.5°C is really difficult. (Not a lot of the analyses in Chapter 4 support this. There’s a section that basically says “if everything goes perfectly, then we might hit it” 1.5°C. Although that brings up another issue, in this chapter there has a lot of repetition of the material in other chapters.) So if you’re not going to talk about SRM, you’re effectively perpetuating conversations about something between a long shot and a fantasy. That seems... odd if we’re talking about the fate of the planet. [Ben Konvitz, United States of America]</td>
<td>Noted.</td>
</tr>
<tr>
<td>1406</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I think some of the treatments of SRM are unfair and wrong. For example, on page 4-7, line 18, SRM certainly could, compensate for all of the warming. There may be reasons why one doesn’t want to do that, so say what those are. I think this treatment would be far more honest and ethical than what is currently in the report, which is effectively, “SRM is off the table.” [Ben Konvitz, United States of America]</td>
<td>Accept. Text is revised to reflect this.</td>
</tr>
<tr>
<td>1408</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I think SRM is also a lot of the same issues that are raised as being applicable to other methods of addressing climate change, so there’s no reason to treat it in a special section. [Ben Konvitz, United States of America]</td>
<td>Reject. SRM is neither mitigation nor adaptation, which warrants a different section</td>
</tr>
<tr>
<td>1409</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SRM is 1.5°C is really disarming... It is kind of all over the place, and I’m not sure what the main message is or what the point of this box is. Also, some of the information is wrong — for example, Eurasia’s net is not well studied, because it’s fairly new. I’ll refrain from offering too many detailed comments along these lines because I feel the box format isn’t the right way to go. [Ben Konvitz, United States of America]</td>
<td>Taken into account. Box 4.13 (in SOD-Cross-Chapter Box 4.2) has been revised and shortened.</td>
</tr>
<tr>
<td>20112</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Chapter 2 authors should ensure that their discussion around potential global responses to climate change are reflected and taken into account in Chapter 2 mitigation pathways. This is particularly true for the discussion of risks and adverse impacts of geoengineering technologies, which should be excluded from responsible mitigation pathways, and for possibilities of more progressive and radical emissions reductions, which should be used as a basis to develop mitigation pathways in Chapter 2. [D.J. Fuh, Germany]</td>
<td>Noted. This would be good but is unfortunately not feasible in the timeframe of this report.</td>
</tr>
<tr>
<td>10004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NOTE: Here are my comments for the special IPCC report on 1.5 degrees. I had unfortunately only free time to go quickly through chapter 4 pages 1 to 64 by the deadline of 24-9-2017 midnight (Saturday night), but could comment most issues that I found important. Please excuse me if I did not have time to find all references. I hope you find my comments being constructive and helpful. You can contact me if you have questions or remarks. Thanks for letting me help IPCC and COP23. Climate is our future and that of our kids. Beatflaggers. Beat Brunner [Beat Brunner, Switzerland]</td>
<td>Noted. Thank you.</td>
</tr>
<tr>
<td>9628</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Some measurements about the adaptation and mitigation for the climate change may be repeated with chapter 2 and chapter 3 in this report, clearly distiguishing the contents in the chapter with chapter 2 and chapter 3 is important. [Jiangang Wu, China]</td>
<td>Accepted. This could not be addressed given the tight deadlines and we are making every effort to reduce overlap in the SOD.</td>
</tr>
<tr>
<td>10913</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The text from page 11 line 14-19 should inbto go in the executive summary because it really the key: The role is determined by political will and the willingness to see energy transitions as a political, social and cultural project—rather than just a technoeconomic one. [Beat Brunner, Switzerland]</td>
<td>Noted and taken into account in the assessment of feasibility which goes well beyond technoeconomic aspects.</td>
</tr>
<tr>
<td>10904</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and from page 11 line 14 emphasizing the possibility and effects of shocks and other types of discontinuous change. [Beat Brunner, Switzerland]</td>
<td>Comment is unclear and is therefore not addressed.</td>
</tr>
</tbody>
</table>
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
7705 | | | | | Missing here and in 4.3.3.1, where it may fit better with reference to this section, is the considerable evidence that modern efficiency, like modern renewables, exhibits expanding return scientific and economic characteristics, and must be considered separately. Models based on scarcity and depletion cannot generate or tolerate expanding returns—e.g., when we buy more photovoltaics (PV) and wind power, they get cheaper, so we buy more, so they get cheaper. EA's wind and PV forecasts have consistently rise 5% and 10% since 2000 without catching up with reality. Fundamental physical and commercial phenomena have made PV costs drop steeply for decades, not rising in a single year. Modern energy efficiency too can get bigger but cheaper, not just through mass-produced widgets like LEDs but also because integrative design spreads rapidly, substitutes brains and information for hardware, and depletes nothing but stupidity. In short, today's energy transition exhibits not the Ricardian economics of scarcity, like diminishing returns to fertilizer and minerals, but the complementary modern economics of abundance, with expanding returns (Arthur 1999, 2004; Nagy et al. 2013). These flow from mass manufacturing of fossil-granular technologies with rapid learning, network effects, and mutually reinforcing innovations. More broadly, today's emergent paradigm for profitable climate stabilization envisages an energy-and-land-use transformation not slowed by incumbent's inertia but sped by insurgents' ambition (Rockstrom et al. 2017; Alleasoz et al. 2017).
Noted. Bottom-up evidence of technology and innovation transitions will be referenced in a section 4.4 (on technology and innovation) and specifically on efficiency in buildings in the section on urban transitions. The points on cost reductions are taken into account in other sections with due references.

20103 | | | | | Since AR4, the IPCC has been criticized for the use of BECCS in RCP scenario. Now, it transfers the consideration of other geoengineering technologies, including a long list of CDR "options." Some techniques are either just theoretical, unheard of or full of risks, like SRM, others have already been shown to have unacceptable impacts. Specifically, ocean fertilization is included in the adapted list of banned marine geoengineering technologies by the London Protocol of the London Convention on the Prevention of Marine Pollution by Dumping of Wastes. Only small-scale laboratory research experiments are exempted after thorough scientific peer review ascertaining the eligibility. How can the IPCC include such a technology as an "option"? [Lil Fuhr, Germany] Accepted. The balance of sections has been reconsidered for the SOD.

933 | | | | | A great deal of emphasis is given to greening urban environment. I think that the amount of emphasis on each section should be proportionate to its relative contribution to greenhouse gas emissions. Those activities that create more emissions should receive more emphasis. Therefore, I think the electric power sector and possible increases in renewable energy and the efficiency of existing plants, as well as CCS, should receive more emphasis. As an introduction to each section, it would be nice if the reader was reminded of the overall emissions worldwide that the sector being discussed is responsible for. For example, the electric power sector is responsible for ~30% overall GHG emissions while land use and deforestation is also responsible for ~30%. Having these numbers for context would allow the reader to prioritize these reduction opportunities. [Elisabeth Aldrich, United States of America]
Accepted. The section has been revised to include these numbers for context.

19023 | | | | | missing reference in ref. Agron 2000. [Sreev Slavebriy, United States of America]
Noted. We are focusing on recent papers and findings, in particular related to 1.5°C. Please note also that we are limited in space and cannot address all issues related to SRM. But ethical section of chapter 4 was revised and trying to cover a wide range of ethical aspects mentioned in the literature.

5958 | | | | | General comment on chapter 4 - A chapter that discusses the global response to climate change may as well include a section on the issues and concerns of climate refugees and the way forward. [Shipta Shaik, Fiji]
Noted. A section has been added on Human migration (Section 4.3.5).

2735 | | | | | Chapter 4 appears to be more innovatively and strategically structured than other chapters, which enhances readability. However, my overwhelming impression is that it is largely urban-based. This risks neglecting the critical rural-urban interactions, as well as the huge areas of rural vulnerability in many countries with very high rural populations currently, and for the interim. A better engagement with rural issues and responses is necessary to underpin statements on ecosystem services and the large majority of food production. [Penny Unsyd, South Africa]
Accepted. Text is restructured for the SOD, based on available literature.

Noted. We are focusing on recent papers and findings, in particular related to 1.5°C. Please note also that we are limited in space and cannot address all issues related to SRM. But ethical section of chapter 4 was revised and trying to cover a wide range of ethical aspects mentioned in the literature.

20154 | | | | | Geoengineering also does nothing to challenge the systems of production and consumption that might be considered unacceptable for reasons other than greenhouse gas emissions associated with them. Comet, A., Poppin, H. (2010) Geoengineering the Climate: The Social and Ethical Implications, in: Environment: Science and Policy for Sustainable Development, Vol. 52, No. 1. [Lil Fuhr, Germany]
Noted. We are focusing on recent papers and findings, in particular related to 1.5°C. Please note also that we are limited in space and cannot address all issues related to SRM.

934 | | | | | In general, the section 4.3.2 should move from mitigation options in the electrical power sector with little discussion of how climate change will affect renewable energy resources like hydro. Should more emphasis be on how these renewables will be impacted by climate change? The focus of the section seems to be on the contribution of these technologies to mitigation; however, as the section moves into land and ecosystems in 4.3.3, the focus is more on adaptation of these systems to climate change. Perhaps adaptation and mitigation should be separate sections with each of the sections appearing in both and addressed separately. [Elisabeth Aldrich, United States of America]
Noted. We have deliberately tried to assess adaptation and mitigation together throughout the chapter, but energy systems indeed gravitate towards mitigation (though adaptation in the electricity sector is there) and the land transect gravitates towards adaptation. We try to balance the literature and the characteristics of the land, energy etc systems require the focus.


The range of land demands would be 4-4.5 times larger than current land areas that have been classified as abandoned or marginal agriculture (Smith et al. 2014). This would require 300-600 GtCO2 to be removed over the course of the 21st century (Creutzig et al. 2015). This is at a time when global food prices are increasing due to the pressures on food production and prices could be substantially ameliorated by using “degraded” or “abandoned” land for BECCS. However, the reality is that hundreds of millions may rely on these lands for income and sustenance (Smolker and Ernsting 2012). 


The range of land demands would be 4-4.5 times larger than current land areas that have been classified as abandoned or marginal agriculture (Smith et al. 2014). This would require 300-600 GtCO2 to be removed over the course of the 21st century (Creutzig et al. 2015). This is at a time when global food prices are increasing due to the pressures on food production and prices could be substantially ameliorated by using “degraded” or “abandoned” land for BECCS. However, the reality is that hundreds of millions may rely on these lands for income and sustenance (Smolker and Ernsting 2012). 


The range of land demands would be 4-4.5 times larger than current land areas that have been classified as abandoned or marginal agriculture (Smith et al. 2014). This would require 300-600 GtCO2 to be removed over the course of the 21st century (Creutzig et al. 2015). This is at a time when global food prices are increasing due to the pressures on food production and prices could be substantially ameliorated by using “degraded” or “abandoned” land for BECCS. However, the reality is that hundreds of millions may rely on these lands for income and sustenance (Smolker and Ernsting 2012). 


The range of land demands would be 4-4.5 times larger than current land areas that have been classified as abandoned or marginal agriculture (Smith et al. 2014). This would require 300-600 GtCO2 to be removed over the course of the 21st century (Creutzig et al. 2015). This is at a time when global food prices are increasing due to the pressures on food production and prices could be substantially ameliorated by using “degraded” or “abandoned” land for BECCS. However, the reality is that hundreds of millions may rely on these lands for income and sustenance (Smolker and Ernsting 2012).
Large-scale BECCS and biodiversity loss. "Many of the potential boxes for bioenergy development are also characterized by high levels of biodiversity, with a large share of endemic species" (Benjamin et al. 2013). Recent research indicates that large-scale BECCS deployment could have profound impacts on biodiversity, primarily of the terrestrial and non-terrestrial megadiversity (Williams et al. 2013). More specifically, BECCS could threaten critical ecosystems such as carbon sequestration efforts in the tropics, and loss of critical habitats for terrestrial megafauna. Williams et al. (2013) conclude that large-scale BECCS deployment could result in a greater degree of terrestial megadiversity than current levels of 2.5% of tropical forest carbon stocks (Williams et al. 2016), due to the human-mediated transformation of ecosystems.

Comment:

Response:

The overall chapter is too long, especially the last 60 pages of text. Apart from the box and text on SRM which are far too long, topics are addressed very superficially. [Evil Helix, Canada]

Comment:

Response:

Taken into account: The chapter is too long. Apart from the box and text on SRM which are far too long, topics are addressed very superficially. [Evil Helix, Canada]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

Taken into account: The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:

The chapter is light on showing the elements supporting the strengthening and implementation of CCS and BECCS as part of the global response. What is needed for first mover demonstration projects in different sectors, for replication deployed in these sectors and for the rapid build-out consistent with the forecasted CCS and BECCS deployment milestones [William Mees, Netherlands]

Comment:

Response:
A general comment for the chapter is that it should reflect the growing literature on supply-side strategies to climate policy, i.e. policies and measures that limit the production of fossil fuels. This is relevant in several parts of the chapter, in particular those that discuss the energy systems. The concept of lock-in is well established (e.g. Umerov G., Energy Pol (2008), 28:817-830). Erickson, P. et al., Environ Risk Lett (2015), https://doi.org/10.1002/errl.221 and highlights how there is a need to actively mitigate against investments that could make it more difficult to achieve ambitious emissions pathways in the future. In the economic literature, there is a growing recognition that actively constraining the production of fossil fuels could be effective in certain cases (Han et al., J. Environ Econ (2012), https://doi.org/10.1016/j.jeconl.2010.05.005; Fehr, T. et al., Energy, J. (2017), https://doi.org/10.1016/j.energy.2017.01.101). A forthcoming special issue of Climatic Change will discuss supply-side policy more in depth, and this should be considered for a more thorough discussion in the report. [Bård Lahn, Norway]


For its latest report, the Intergovernmental Panel on Climate Change (IPCC) analyzed about 900 scenarios from about 30 integrated assessment models. These models determine a cost-effective mix of technologies, based on estimated technology costs and climate policy, including carbon pricing. Of the 116 scenarios with a 50% or better chance of limiting global warming to 2°C by 2100, 101 include CDR, mostly BECCS, in the technology mix for the second half of the 21st century. Across these scenarios, the median commitment to carbon dioxide removal from BECCS in 2100 is about 12 billion tons of CO2 per year, equivalent to more than 25% of current CO2 emissions. This is truly massive use of a technology with little real-world experience and poorly known economics. The requirements for land and water are large but unclear. Based on relatively optimistic assumptions about future yields, the BECCS commitment corresponds to 5-6 to 0.7 billion ha of productive land, more conservative assumptions yield a land requirement of 1.2 billion ha. The range is about 25 to 80% of total current global cropland or up to 8% of Earth’s land area. Converting land on the staggaring scale would pit climate change responses against food security and biodiversity protection. Relatively expanding managed land for CDR could crash through the planetary boundary for sustainable land use. Field, C.B./Mach, K.J. (2017) (Righting carbon dioxide divorce, in: Science, Vol. 356, No. 6339, pp.706-707). Chapter 2 authors should make the implications of the assumptions made in the models very clear to readers and policymakers. See also J. Rockstrom et al., Ecol. Soc. 14, 32 (2009) on planetary boundaries, W. Steffen et al., Science ,347, 1259855 (2015), Smith et al. 2016 Biophysical and economic limits to negative CO2 emissions, in: Nature Climate Change 6, 42-50, doi:10.1038/nclimate2870 [Jul Furr, Germany]

I don’t have any real comments on this chapter in part because the text is not complete and mostly because I had a very hard time figuring out the purpose and center of gravity for the analysis. It is truly massive in length yet most of the text covers topics that I could have seen covered in other chapters. The text never grapples in a central, organized way with the topics involved in this lock-in strengthening and implementing the global responses. I think a much clearer division of labor is needed with other chapters (see chapter 2, regarding which chapter should handle practical issues of scaling up different options) and it needs a tighter set of arguments about what is most important for scaling up the global responses. I also commented that the title, at least, implies that this is the chapter where the study of governance issues should be handled. A pretty substantial barrier to strengthening the policy, this chapter and emphasized by the reviewer. Side effects have been highlighted (even more systematically in the SSD report) and the interaction with sustainable development are covered in chapter 5. [Bård Lahn, Norway]

In sum, Chapter 4 pays inadequate attention to governance and other responses in the Global South, treating these explicitly as matters for the sustainable development agenda (and thus Chapter 5). The North and Northern consumers are treated as global norms. There is not a lot in the chapter that I think fundamentally wrong but there is a lot that requires qualification to provide insight into both the relevance and limitations. It is not that we cannot generalize from social and institutional research but we do need to be clear about what we can generalize to, and not attempt to follow the lead of sciences that can unproblematically be generalized globally. [Stewart Lockie, Australia]

A few miscellaneous final thoughts:

-- Consider adding “and sub-national” after “national” strategically throughout the document in order to reinforce the idea that the issues apply to states and regions, as well as national and cities.

-- Spell check sometimes hyphenated terms for consistency (e.g., C40-40 and sub-nationalism/h.

-- Annote the Box belong in the Table of Contents. Let the reader know, for example, that Box 4.1.5 provides examples of institutional cooperation (among governments, multilateral institutions, private organizations and NGOs). It’s a seven and a half pages long with five case studies, which the reader of the TOC would never guess from the one-word title “Adaption.” [Stephen Wiel, United States of America]

Taken into account, briefly. Literature on reducing production of fossil fuels is (surprisingly) sparse. Such is addressed in section 4.2. [Jul Furr, Germany]

Taken into account. We are happy that we can build on new literature that emerged after the FOD on ecosystem restoration (Gleason et al., 2017), which demonstrates that the mitigation potential could even be higher and we also explicitly mention the co-benefits now. Please note that the use of ecosystem restoration is further allocated to 4.3.5 in the SSD and that (b) blue carbon etc. had already been covered in the former 4.3.6 in the FOD.

Taken into account. -- Chapter 4 authors have assessed all CDR options along the feasibility criteria laid out in chapter 1 and emphasized by the reviewer. Side effects have been highlighted (even more systematically in the SSD report) and the interaction with sustainable development are covered in chapter 5. [Jul Furr, Germany]

Note: We have certainly tried to improve the structure and to include more relevant test on policy issues and incentives.

Takin into account, sub-national may be added as appropriate if supported by relevant literature. Editorial, spell checks will be done. Table of contents per IPCC style guide. The title of Box 4.1.5 (SSD Cross-Box 4.3.4) now better reflects the contents (risk, adaptation interventions, and implications for sustainable development and equity across five systems: Arctic, Caribbean, Mekong Delta, Amazon, and others).
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comment</td>
<td>Response</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>905</td>
<td>Comment</td>
<td>Note that it says &quot;several&quot; but only one example is given. Good to list all?</td>
<td>[Érika Mata, Sweden] Rejected; unclear which section this comment refers to.</td>
<td></td>
</tr>
<tr>
<td>7094</td>
<td>47-48</td>
<td>This chapter fails to grasp the essence presented in Chapter 2 and instead portrays an overly optimistic picture of the transition to a 1.5°C society. With current warming exceeding 1°C and a carbon budget around 350 Gt presented in Chapter 2, warming above 1.5°C may be locked in before the end of the 2020s. The Paris Agreement will be slow to react given its 5 year turnaround structure, presenting a challenge that is not conveyed in this chapter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4897</td>
<td>4-7</td>
<td>This chapter fails to grasp the essence presented in Chapter 2 and instead portrays an overly optimistic picture of the transition to a 1.5°C society. With current warming exceeding 1°C and a carbon budget around 350 Gt presented in Chapter 2, warming above 1.5°C may be locked in before the end of the 2020s. The Paris Agreement will be slow to react given its 5 year turnaround structure, presenting a challenge that is not conveyed in this chapter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1079</td>
<td>4-6</td>
<td>We need a more balanced chapter. The chapter is perhaps the least of all times I read (2.3.4) It is very much centered in explaining the key role BECCS will need to play if we are to attempt to reach any 1.5°C scenarios. However I am worried the AFOLU sector role assessment is superficial and dismisses some of the new and ongoing findings about the role forests and oceans play and will need to play in reaching the emissions targets. One third of emissions are absorbed by forests as they are and this needs to be recognized as part of the solution. Particularly because any 1.5°C solutions will definitively need of forests to reach its goals. The way the sector is treated in the chapter, this is not really apparent or reinforced and seems to assume these services as a given, yes, the idea of afforestation/reforestation is pretty much there. However the way this is not in the qualities of such processes to be successful yet some cautions are certainly as well as their services. My point here is: This is the proven concept by nature and the system we know &quot;best&quot; (still learning a lot though via REDD+ capacity building) and the proven one the others are a proof efficient process, yes, a lot of uncertainties remain but, as many as with BECCS implementation, this takes me to a following point. A lot of the needs for BECCS implementation as well as unknowns are left aside and need be explained as well [National Marine Aquaculture, United States of America]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5438</td>
<td>4-6</td>
<td>It is suggested that this chapter is somehow restructured. The various 1.5°C scenarios identified in chapter 3, box 3.12 could be a starting point. The next step should be to explain the treatment of SRM which limits the scenarios conceivable. The next step would be to focus on these scenarios that offer a significant reduction of climate change risks. And then the information included now in chapter 4 should be presented. But it need to be put into a clear narrative and tag storyline, e.g. by following the above suggestions. [Klaus Radunsky, Austria]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5439</td>
<td>4-6</td>
<td>It is suggested that the idea of BECCS is matched over Chapter 2, while the linkage with Chapter 3 will be further improved for the Final Draft. However, the specific suggestion was challenging to fit with the approved outline for chapter 4 and is therefore rejected.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6722</td>
<td>4-6</td>
<td>Chapter 4 should clearly identify what is necessary to move along reasonable scenarios and what has to be done to avoid to move into scenarios that result in significant higher risks. [Klaus Radunsky, Austria]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Taken into account. The SOD reflects better linkages between O2 and C2 (e.g. Table 4.1) and this is further improved in the Final Draft. The reviewer's point is also considered in the Cross-chapter box 4.1 on NDCC.

Taken into account. This is a valid comment. Please note that the assessment for the AFOLU section had not been completed during the FOD thus giving a superficial impression. Afforestation had only been dealt with in the context of its ability to withdraw CO2 from the atmosphere in the former section 4.3.6. In the SOD, we now include an assessment of ecosystem restoration and avoided deforestation. We are happy that we can build on new literature that emerged after the FOD as well as that (Griscom et al. 2017), which demonstrates that the mitigation potential could even be higher and we also explicitly mention the co-benefits now.

Taken into account. The SOD reflects better linkages between O2 and C2 (e.g. Table 4.1) and this is further improved in the Final Draft. The reviewer's point is also considered in the Cross-chapter box 4.1 on NDCC.

Taken into account. This is a valid comment. Please note that the assessment for the AFOLU section had not been completed during the FOD thus giving a superficial impression. Afforestation had only been dealt with in the context of its ability to withdraw CO2 from the atmosphere in the former section 4.3.6. In the SOD, we now include an assessment of ecosystem restoration and avoided deforestation. We are happy that we can build on new literature that emerged after the FOD as well as that (Griscom et al. 2017), which demonstrates that the mitigation potential could even be higher and we also explicitly mention the co-benefits now.

Noted. Thank you for those detailed suggestions. In the SR1.5, we were assigned to look at options (mitigation and adaptation) that are either 1.5-specific or need a significant update since the AR5. Though significant options, the suggestions here have been treated extensively in AR5.
Limited mention of government networks associations such ICLEI etc as catalysts for norm formation and climate resilient development pathways. [Alan Adu-Bostang, United Kingdom (of Great Britain and Northern Ireland)]

Taken into account. In the header of section 4.4, new text is included: "The emergence of polycentric loci of climate action and the transnational and subnational networks that link these efforts (Abbott, 2012), offer the opportunity to experiment and learn from different approaches, thereby accelerating the process led by national governments (Cole, 2015a; Jörden et al., 2015)."

We recommend to include case studies also from Europe and Northern America as we are far from this part of the world. Countries in this part of the world also needs motivation and to learn from other countries in similar economic and social situations about how to mitigate emissions. [Byynnd Christophersen, Norway]

Taken into account. We aimed for a good balance between regions and some examples of Europe appear in Box 4.1 and Box 4.5. Inclusion of additional case studies for Europe and Northern America has been considered but we are constrained by the non-availability of peer-reviewed literature for relevant case studies.

Please consider to use the language for consistent treatment of uncertainties according to the IPCC guidance for Lead Authors more extensively for the executive summary as appropriate. [Byynnd Christophersen, Norway]

Accepted. We have tried to outline the storyline more explicitly in 4.1 and also start the 4.x.

Please consider discussing reduction of transport activity as a mitigation option. [Byynnd Christophersen, Norway]

Accepted, has been considered in section 4.3.4.2

Please consider discussing future potentials for autonomous freight and passenger transport. [Byynnd Christophersen, Norway]

Accepted, we have added text on driverless cars in section 4.3.4.4

Consider adding a discussion of to what extent important assumptions in the models are simplifications, and how for example lack of perfect foresight, perfectly credible long-term climate mitigation goals, and perfect rationality in the real world could be handled in policy. [Byynnd Christophersen, Norway]

Rejected. Although this comment is very important, this discussion belongs to Chapter 2 and is outside the scope of this Chapter.

Considering the important role that small and medium sized cities play in the development of large urban areas in Africa are small and medium sized towns. [Van der et al. 2015 Cities & Towns Africa pdf]


Noted Noted. Relevant point but in a report this broad and generic, a focus beyond urban to small-town urban is getting too detailed.

Consider adding a more detailed discussion of market failures and barriers. The chapter considers global carbon-pricing, but seems to lack a thematic basis for a more comprehensive mitigation policy portfolio. Examples of elements which you could consider for inclusion are: technological lock-in, political risk of investment in low-carbon technologies due to lack of credibility of long-term mitigation goals, effects of learning-by-doing, scaling effects, important information in financial markets, asymmetrical information between consumers and producers, research and development as a common good, the standing on shoulders effect, and knowledge diffusion. This chapter should also address more technology specific market failures and barriers, such as the formation of natural monopolies in the CCS-chain, or the problem of integrating renewable energy sources such as wind and solar in deregulated energy markets. [Byynnd Christophersen, Norway]

Noted. We received earlier comments that we should be 1.5C-specific in this report. We are also keenly constrained in page limits. A barrier / feasibility analysis is included in section 4.5.

Chapter 4 may be combined with Chapter 5, because the global responses should be in line with the SDGs. [Hong Yang, Switzerland]

Rejected, Chapter as per agreed plenary outline.

Much of the text in Chapter 4 is too general and lack specific action oriented measures that are targeting to 1.5C warming. Also contents in some subsections are repetitive and permissive. It lacks a main string to connect all the sections. [Hong Yang, Switzerland]

Accepted. Text has been revised and rewritten for the SOD, taking this into account.

Missing from chapter 4 is any consideration of the potential for reducing emissions via reduced material waste / linear material consumption by individuals (although the circular economy is briefly mentioned in section 4.3.4.3 on industry). [Alan Smith, United Kingdom (of Great Britain and Northern Ireland)]

Accepted. In the SOD, industrial systems has become a separate section (4.3.5) with more consideration for materials, for example in the subsection 4.3.5.2 bio-based and circularly.

Climate services play an important role in strengthening climate mitigation and adaptation efforts, thus I believe it needs to be mentioned explicitly in this chapter. Please, see my specific comments below. [Jyntkamia Lehto;u:ty: Finland]

Accepted, climate services are included in section 4.3.3.1.

Overall, I feel like large parts of this report do not focus on the 1.5C target specifically, it is more like an intermediate AR6 but less detailed. This is partly due to the lacks of studies focusing on that target but I'm afraid that this work and the forthcoming AR6 will be too similar [Philipp Rouxler, France]

Noted. 1 November 2017 is the deadline for paper submissions, to be considered for inclusion in the SR1.5. We are still expecting additional relevant literature that is specific to 1.5C.

Many literature quotes are in the formal “author, year” while many others in the informal “author year” without comma in between. Please establish one format (in accordance to the rest of the Report). [Valentino Piana, Italy]

Accepted.

Limited mention of government networks associations such ICLEI etc as catalysts for norm formation and climate resilient development pathways. [Alan Adu-Bostang, United Kingdom (of Great Britain and Northern Ireland)]

Taken into account. The header of section 4.4, new text is included: "The emergence of polycentric loci of climate action and the transnational and subnational networks that link these efforts (Abbott, 2012), offer the opportunity to experiment and learn from different approaches, thereby accelerating the process led by national governments (Cole, 2015a; Jörden et al., 2015)."

Also, refer to SOD section 4.4.1 where the ICLEI and other networks/associations are mentioned as examples.

Many literature entries are quoted in the format “author, year”, while many others in the format “author year” without comma in between. Please establish one format (in accordance to the rest of the Report). [Valentino Piana, Italy]

Accepted.

Limited mention of government networks associations such ICLEI etc as catalysts for norm formation and climate resilient development pathways. [Alan Adu-Bostang, United Kingdom (of Great Britain and Northern Ireland)]

Taken into account. The header of section 4.4, new text is included: "The emergence of polycentric loci of climate action and the transnational and subnational networks that link these efforts (Abbott, 2012), offer the opportunity to experiment and learn from different approaches, thereby accelerating the process led by national governments (Cole, 2015a; Jörden et al., 2015)."

Also, refer to SOD section 4.4.1 where the ICLEI and other networks/associations are mentioned as examples.

Many literature entries are quoted in the format “author, year”, while many others in the format “author year” without comma in between. Please establish one format (in accordance to the rest of the Report). [Valentino Piana, Italy]

Accepted.
This chapter does not really produce an assessment of a global response, but is more sectoral, partial and case-study specific. This is not necessarily a problem if the message is precisely to say that global response cannot be given but only one based on discrete examples of actions and instruments that work which can help to meet the 1.5°C target following the Paris 'triple shift' (in contrast to the one-angle global top-down approach which failed in Copenhagen). Global, in contrast to world or a large at planetary (human scale) refers merely to 'interconnected'. However, at present, this report: 1. Omits the characterisation of several global systems crucial for meeting the 1.5 target, such as global trade systems, global information systems or even the important role played by large-scale military systems and military R&D and investments. 2. It does not show clearly the interconnections between different global systems so as to assess synergies and trade-offs between different levels of interventions and the possible systems of global solutions which could be implemented to harness various global systems dynamics as to meet the 1.5°C challenge (see the emerging Global Systems Science) and 3. No additional or new global integrated targets or a transformative integrated narrative is included in this chapter specifically targeted to the 1.5 challenge and linked to discussions in section 2.5.1 and table 2.13 in Chapter 2 which only focuses on new modelling climate and SSPs combinations, and not on global societal transformations and how to implement them (like for instance, a narrative which could inform about how much fossil fuels should be kept in the ground to limit global fossil-fuels demand and how this should be combined with concrete positive policy measures and an engaging discourse at a global level (despite few ascet ideas such as the notion of unburnable oil and stranded assets is partially addressed in the chapter) [J. David Tabara, Spain]

The chapter may require providing a clearer distinction between the understanding of 'conventional' versus 'transformative' adaptation and mitigation strategies. The chapter only talks about 'transformative adaptation' but omits the role of 'transformative mitigation'. Transformation is mostly an autonomous dimension related to achieving sustainability or in current policy practice, the SDGs. Hence, many of the technological 'solutions' and innovations which are often put forward as candidates to meet the 1.5°C challenge if not achieved to align sustainability and support support of institutional change are conventional in nature, despite its large-scale ambition - and therefore likely to create even greater and more difficult to solve problems. [J. David Tabara, Spain]

The chapter requires more emphasis in characterizing distributed and the agency accountable for the decision derived from this chapter. In other words, and with the exception of local actors and cities, at present the report focuses too much on 'what the problem' rather than on systematically characterizing and assessing 'what is the solution' - e.g. who should pay or could benefit from implementing such actions, etc. In implementing such actions, including future generations. For instance, the role of corporate responsibility is missing, while some large corporations constitute some of the largest potential players in GHG reduction - even targeted at some states. Emerging literature is growing regarding this regard, e.g. by Karen O'Brian or at the EU project IMPRESSIONS, see for instance, last chapter of Berry, P.M., Betts, R.A., Harrison, P.A. and Sanchez-Arcilla, A. (Eds.) 2017. High End Climate Change in Europe. Available at http://highendclimatestress.eu/; but there are many others from political science. [J. David Tabara, Spain]

There is quite significant overlap on response options (esp. mitigation, and land-based transitions) with Ch 5 (5.4) and also Ch2. To be discussed at There is an imbalance between mitigation and adaptation. It is not clear where adaptation is actually discussed [Elvira Poloczanska, Germany] Accepted. We strive for a good balance between mitigation and trade-offs are included in the next draft. On point 3. This point is repaired through Table 4.1. 6593

This chapter lacks an on adaptation. [Petra Tschakert, Australia]

Consider trying to put a much further attention to the the literature on social and sustainability learning in the report and also in particular in section 4.4.12 - as the whole point of the report seems to be that we need to engage in a social learning process. this current subsection focus on technical and policy systems while omitting the role of cultural and social systems dynamics besides weeneue work by Ostrom you may consider, for instance Tabara, J. D.; & Chiap, J. 2013. Coupling human information and knowledge systems with social-ecological systems changes. Reframing research, education and policy for sustainability. Special Issue on “Responses to Environmental and Societal Challenges for our Unstable Earth (RESCUE)”. Environmental Science and Policy. 28: 71-81. Tabara, J. D. and C. Pahl-Wostl 2008. Sustainability Learning in Natural Resource Use and Management. Ecology and Society, 12(2): 3 [online] URL: http://www.ecologyandsociety.org/vol12/iss2/art3/index.html; Tàbara, J. D., Ooi, K., Jia, S., McFadyen, D., Neufeldt, H., Sierra, A., Wiemers, S., and West, J. 2010: The Climate Learning ladder: A pragmatic approach to support climate adaptation. Environmental Policy and Governance, 20:1-11, mostly because the 1.5°C challenge can be seen as a ‘social learning race against time’, not just a technological problem [see Tabara, J. D. 2013: Social learning to cope with global environmental change and sustainability. In: Stewart Lockie, David A. Sonnfelder, and Dana W. Fisher (eds.). The Routledge International Handbook of Social and Environmental Change. London and New York: Routledge, pages 252-265]. [J. David Tabara, Spain]

There is a significant overlap on response options (esp. mitigation, and land-based transitions) with Ch 5 (5.4) and also Ch2. To be discussed at 4.2. Social learning race against time, Thats a good one. It is briefly - addressed in section 4.2.2

Accepted, for discussion at LAR05 and is improved in next version.

There is a need to identify gaps in the literature on social and sustainability learning in the report and also in particular in section 4.4.12 - as the whole point of the report seems to be that we need to engage in a social learning process. this current subsection focus on technical and policy systems while omitting the role of cultural and social systems dynamics besides weeneue work by Ostrom you may consider, for instance Tabara, J. D.; & Chiap, J. 2013. Coupling human information and knowledge systems with social-ecological systems changes. Reframing research, education and policy for sustainability. Special Issue on “Responses to Environmental and Societal Challenges for our Unstable Earth (RESCUE)”. Environmental Science and Policy. 28: 71-81. Tabara, J. D. and C. Pahl-Wostl 2008. Sustainability Learning in Natural Resource Use and Management. Ecology and Society, 12(2): 3 [online] URL: http://www.ecologyandsociety.org/vol12/iss2/art3/index.html; Tàbara, J. D., Ooi, K., Jia, S., McFadyen, D., Neufeldt, H., Sierra, A., Wiemers, S., and West, J. 2010: The Climate Learning ladder: A pragmatic approach to support climate adaptation. Environmental Policy and Governance, 20:1-11, mostly because the 1.5°C challenge can be seen as a ‘social learning race against time’, not just a technological problem [see Tabara, J. D. 2013: Social learning to cope with global environmental change and sustainability. In: Stewart Lockie, David A. Sonnfelder, and Dana W. Fisher (eds.). The Routledge International Handbook of Social and Environmental Change. London and New York: Routledge, pages 252-265]. [J. David Tabara, Spain]

5968

Table 4.1 on sectoral policy targets based on Chapter 2. Accepted. Thank you and we focussed on improving this for the SOD. 6599

4309

Remark: we strive for a good balance between mitigation and adaptation and this has been improved in the SOD. [J. David Tabara, Spain]

10210

Accepted, Thank you and we focused on improving this for the SOD. 10456

Partly accept. 1. Only qualitative information from peer-reviewed literature can be included. Some of the information requested by the reviewer can be found in Chapter 2. 2. More graphics have been included in the SOD and will be further refined for inclusion in the Final Draft. 3. Accepted. Section 4.2 has been redrafted to avoid overlaps with Chapter 2: the revised section include Table 4.1 on sectoral policy targets based on Chapter 2.
The title of the chapter is not fully reflected in the content of the chapter and in the way it is presented. Changes in titles and position of text portions, together with substantial extension of certain materials, are necessary. The chapter does not describe the current global response to climate change, as it is ill-positioned to propose its strengthening and its implementation. The chapter has a lot of pages on sectoral responses but almost nothing on international (bilateral and multilateral) responses to climate change. It neglects UNFCCC and other important multilateral frameworks and paves a very uncertain empirical local existence. To partially improve things, the following recommendations are issued. Box 4.12 should be moved as an autonomous chapter 4.3 just before the current 4.3 (current page 10) and re-labeled "the current international response to climate change" with integrative text to correspond to this broader title, including 1. a wider analysis of the more than 2000 pages of NDCs and 2. all key themes of the Paris Agreement and accompanying modules (both within and outside the UNFCCC). The current 4.3 title ("Assessment...options") should be renamed as "Assessment of current options for enhancing the ambition of NDCs and of multi-stakeholder partnerships". [Valentino Piana, Italy]

Tightening the focus on the removal of fossil fuel subsidies - especially and first of all.
The sections referring to SLCPs are misleading, frankly. The root cause is the lumping together of several substances under the SLCP umbrella, while these have very different characteristics, climate effects, co-emission relations with CO2 and policy measures to achieve reductions. Often in this chapter, SLCPs are mentioned as beneficial for some purpose or another, while the particular benefit only applies to one or two of the substances lumped together and not to all of the others. This seems scientific bad practice and is unhelpful for policy purposes. [Michiel Schaeffer, Netherlands] Accept. Will look at instances where we discuss SLCPs and make sure we don’t overgeneralise.

Please make sure all papers under review, inaccessible grey literature, and foreign language abstracts translated to English all are used in Chapter 4’s FGO and SOD are uploaded to a clearly identifiable folder in DM [William Mollison-Smith, Free stage] Accept.

Throughout the discussion of SRM, the draft gives the impression that the current state of knowledge, regarding both science and policy, is more advanced—and more uncertain—than is actually the case. As we see things, knowledge about solar geoengineering remains in its early stages and is characterized by considerable uncertainty; yet, the limited evidence that does exist suggests that SRM could be a highly beneficial climate policy tool if carefully used in combination with other strategies, in particular emissions mitigation. Several examples illustrate this point. [Joshua Horton, United States of America] Taken into account. We attempt to give a balanced account and will continue to look at this in the SOD.

This is probably obvious to the authors but the chapter is currently very patchy, with some sections full and reasonable coherent, others highly fragmentary. There is quite a lot of material that is quite generic and ought to be made more focused on the challenge of 1.5°C specifically. [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)] Accepted. This has been revised.

Please see the bibliography of p22-iteratively new or unfamiliar references that I will attempt to upload. If you do not receive it, please email amory@rmi.org immediately with instructions where to email it. The rest of my comments refer to its contents. It contains a mix of peer-reviewed journal articles and other publications in respected venues, including some major book-length studies that are far too long for that format but are extensively peer-reviewed and of proper quality and rigor. Your Draft’s current references include some sources not in peer-reviewed journals (e.g. Sze 2014, Christensen 1997) and are considerably less deep and detailed. [Amory Lovins, United States of America] Noted. Grey literature will be assessed as per IPCC guidelines. This has been revised.

Please see the bibliography of p22-iteratively new or unfamiliar references that I will attempt to upload. If you do not receive it, please email amory@rmi.org immediately with instructions where to email it. The rest of my comments refer to its contents. It contains a mix of peer-reviewed journal articles and other publications in respected venues, including some major book-length studies that are far too long for that format but are extensively peer-reviewed and of proper quality and rigor. Your Draft’s current references include some sources not in peer-reviewed journals (e.g. Sze 2014, Christensen 1997) and are considerably less deep and detailed. [Amory Lovins, United States of America] Noted. Grey literature will be assessed as per IPCC guidelines. This has been revised.

Overall, the one significant absence in the chapter, given its role in the special report as a whole, is the lack of a careful consideration of, and review of appropriate literature, the political challenge of pursuing the 1.5°C target. That is, we know roughly what technologies are involved, and how quickly they need to be deployed, and we can quantify how much needs therefore to be made up by behavioural change – transport mode switching, etc. But what really determines whether or not these changes can be realized will be securing the policies, investments, and rapid social change involved against political backlash. The only real discussion of this, beyond the odd mention in passing, is in the discussion on p63 on ‘public support’ (which is a subsection in the section on behavioural change, whereas the issues there are not specific to behavioural change), and this is rather inadequate, as explained in a comment on that passage. But we can say much more specific things about what the political challenges will be, and there is plenty of literature that could be used to support these claims. 1. resistance can be expected from incumbent economic interests who will lose out from the rapid transition through their ‘stranded assets’. There is now a substantial literature on that (some of which is mentioned here in other contexts) but also a very large literature on corporate lobbying on climate change which could be brought to bear on that question (see work especially by Peter Newell, Matthew Paterson, David Levy, Ann Kolb, and others). Some of this has been incorporated into the socio-technical transitions literature (see for example Geels, Frank W. 2014. ‘Ragnene Resilience against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective’ Theory, Culture & Society 31:21–40). 2. resistance can be expected by those particularly attached to high carbon practices – dining, flying, and so on. The literature on this is perhaps less well developed but at least some elements form Bukeczy, Harriet, Matthew Paterson, and Johannes Stridpe, eds. 2016. Towards a Cultural Politics of Climate Change. Cambridge: Cambridge University Press, could be used to think about this. 3. we can expect conflicts over the distributive impacts of the rapid transition. Much of this is well-known but needs to be understood not only ethically - as a question of whether some will lose out from clients policy - but politically, in terms of whether and how this might block the rapid transition involved in pursuing 1.5°C. There are already cases of this playing out, especially over conflicts over energy price rises. Leach Stakes (Leach, Leach. 2013. The Politics of Renewable Energy Policies: The Case of Feed-in Tariffs in Ontario, Canada. Energy Policy 36:490–503). For example shows how this worked in relation to Ontario’s Feed in Tariff which still threatens to derail climate policy there. Other cases as in Australia are well known. And of course these different sources of political backlash can combine (again, the Australian carbon pricing case is paradigmatic). Integrating a discussion of these literatures and themes explicitly would enable a much sharper analysis of the things that governments seeking to pursue policy towards 1.5°C would have to consider if they were serious about that goal, and thus enhance the policy-relevance of the chapter significantly. [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)] Accept, this is further addressed in section 4.4.3 as well as in section 4.4.5 and 4.4.6. We also address it in the feasibility assessment in 4.4.
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>7792</td>
<td>1</td>
<td>134</td>
<td></td>
<td></td>
<td>I will now try to paste that bibliography here in case I can't upload it in one Word document. Here it is in two pieces (just some possible delete at the end of the first box, call 158 or 158—Excel was never designed for such use!). Additional references—any of mine not immediately available will be emailed on request to <a href="mailto:amory@rmi.org">amory@rmi.org</a> (my private address, my published address is <a href="mailto:ablovins@rmi.org">ablovins@rmi.org</a>). A bug in your spreadsheet seems to be preventing the Chapter column in row 17 from entering, as the second half of the bibliography is not uploading; I'll try it again at the end of the spreadsheet.</td>
<td>Noted, with appreciation. Most of these references are seminal works cited in earlier IPCC assessments. 1.5C relevant literature in the post-AR5 period will be considered</td>
</tr>
</tbody>
</table>


Griscom B et al. (2017) Natural pathways to climate mitigation. PNAS, in press.


Lovins RMI (2011) Reinventing Fire. Chelsea Green, [www.rmi.org/reinventingfire](http://www.rmi.org/reinventingfire) [Amory Lovins, United States of America]
### Comment 1

I will now try to paste that bibliography here in case I can’t upload it in one Word document. Here it is in two pieces (plus some possible detritus at the end of the first box, cell 13B or 16B—Excel was never designed for such use!). Additional references; any of mine not immediately available will be emailed on request to amory@rmi.org (my private address; my published address is ablovins@rmi.org). A bug in your spreadsheet seems to be preventing the Chapter column in row 17 from entering, so the second half of the bibliography is not uploading; I’ll try it again at the end of the spreadsheet.


Griscom B et al. (2017) Natural pathways to climate mitigation. PRAS, in press.


**Note:** See response to comment 7792

---

**Do Not Quote, Cite, or Distribute Page 13 of 159**
Section 3 of chapter 4 is supposed to give an “assessment of current and emerging options”. It is outrageous that nuclear energy is not even mentioned while ES (electric power of nuclear reactors) are under construction. 168 are planned and 400 are proposed (World Nuclear Association). Several sustainable options of the fossil fuels burning type are in the industrial development stage in Russia, China and India (with a project in France). Therefore, an active role on high temperature and intermediate temperature in the GHG international collaborative program. Is this absence in chapter 4 due to ignorance or to ideological bias? Furthermore, Nuclear energy may be an extremely important element for limiting the GMST as can be seen in a recent article “How much can nuclear energy do about global warming?”. In any case I urge the lead authors to complete the list of authors by real experts in Nuclear Power. [Herve Nifenecker, France]

Section 4.3.4.1.3: sustainable water and environmental services - the section description flags a mixed opportunity of the report to concentrate on the Food-Energy-Water nexus. This is a considerable gap and the report authors will be well advised to fill it in the gap; rename the section to “Sustainable food-energy-water management” and reflect the new emphasis throughout the text and in the respective subsection. [Yana POPKOSTOVA, France]

Right justified leaving dots on left instead of right [Mohito Kim, United Kingdom (of Great Britain and Northern Ireland)]

10546 4 1 100 55

Correct. It is not clear the 1.5C degree scope. Most of the sections of chapter could be written for 3C, 2C or 1C or 1.3C. You should be clear what 1.5C (and not 2C or 3C) would require of extra efforts in different aspects... [Jose Antonio Puppim de Oliveira, Brazil]

1538 4 18 43 23

Accept. We have included a subsection on nuclear in the energy transitions section.

13101 4 25 4 25

Accept. We have included a subsection on nuclear in the energy transitions section.

10547 4 41 100 55

Accpet. We are noting the implementation gap as well as the NDCs emission gap to 1.5 or 2C.

3010 4 46 51

How can this statement be written in the same report where one whole chapter is devoted to models assessment of decarbonization pathways? In addition, such extrapolation is done using scenarios and models over relatively long time periods (typically several decades) assuming different growth rates and patterns “Add something like: which is indeed the topic of a full chapter of this report. I understand here and in subsequent parts of this intro the idea is to criticize the IAM conclusions. In Innovation and the Transition to Sustainability: Theory, Evidence and Policy. Edward Elgar, Cheltenham, pp. 48–75.

Valentina Bosetti, Italy

Solution. It is not clear the 1.5C degree scope. Most of the sections of chapter could be written for 3C, 2C or 1C or 1.3C. You should be clear what 1.5C (and not 2C or 3C) would require of extra efforts in different aspects... [Jose Antonio Puppim de Oliveira, Brazil]

1538 4 18 43 23

Accept. We have included a subsection on nuclear in the energy transitions section.

13101 4 25 4 25

Accept. We have included a subsection on nuclear in the energy transitions section.

10547 4 41 100 55

Accept. We are noting the implementation gap as well as the NDCs emission gap to 1.5 or 2C.

3010 4 46 51

How can this statement be written in the same report where one whole chapter is devoted to models assessment of decarbonization pathways? In addition, such extrapolation is done using scenarios and models over relatively long time periods (typically several decades) assuming different growth rates and patterns “Add something like: which is indeed the topic of a full chapter of this report. I understand here and in subsequent parts of this intro the idea is to criticize the IAM conclusions. In Innovation and the Transition to Sustainability: Theory, Evidence and Policy. Edward Elgar, Cheltenham, pp. 48–75.

Valentina Bosetti, Italy

Solution. It is not clear the 1.5C degree scope. Most of the sections of chapter could be written for 3C, 2C or 1C or 1.3C. You should be clear what 1.5C (and not 2C or 3C) would require of extra efforts in different aspects... [Jose Antonio Puppim de Oliveira, Brazil]

1538 4 18 43 23

Accept. We have included a subsection on nuclear in the energy transitions section.

13101 4 25 4 25

Accept. We have included a subsection on nuclear in the energy transitions section.

10547 4 41 100 55

Accept. We are noting the implementation gap as well as the NDCs emission gap to 1.5 or 2C.

3010 4 46 51

How can this statement be written in the same report where one whole chapter is devoted to models assessment of decarbonization pathways? In addition, such extrapolation is done using scenarios and models over relatively long time periods (typically several decades) assuming different growth rates and patterns “Add something like: which is indeed the topic of a full chapter of this report. I understand here and in subsequent parts of this intro the idea is to criticize the IAM conclusions. In Innovation and the Transition to Sustainability: Theory, Evidence and Policy. Edward Elgar, Cheltenham, pp. 48–75.

Valentina Bosetti, Italy

Solution. It is not clear the 1.5C degree scope. Most of the sections of chapter could be written for 3C, 2C or 1C or 1.3C. You should be clear what 1.5C (and not 2C or 3C) would require of extra efforts in different aspects... [Jose Antonio Puppim de Oliveira, Brazil]

1538 4 18 43 23

Accept. We have included a subsection on nuclear in the energy transitions section.

13101 4 25 4 25

Accept. We have included a subsection on nuclear in the energy transitions section.

10547 4 41 100 55

Accept. We are noting the implementation gap as well as the NDCs emission gap to 1.5 or 2C.

3010 4 46 51

How can this statement be written in the same report where one whole chapter is devoted to models assessment of decarbonization pathways? In addition, such extrapolation is done using scenarios and models over relatively long time periods (typically several decades) assuming different growth rates and patterns “Add something like: which is indeed the topic of a full chapter of this report. I understand here and in subsequent parts of this intro the idea is to criticize the IAM conclusions. In Innovation and the Transition to Sustainability: Theory, Evidence and Policy. Edward Elgar, Cheltenham, pp. 48–75.

Valentina Bosetti, Italy

Solution. It is not clear the 1.5C degree scope. Most of the sections of chapter could be written for 3C, 2C or 1C or 1.3C. You should be clear what 1.5C (and not 2C or 3C) would require of extra efforts in different aspects... [Jose Antonio Puppim de Oliveira, Brazil]

1538 4 18 43 23

Accept. We have included a subsection on nuclear in the energy transitions section.

13101 4 25 4 25

Accept. We have included a subsection on nuclear in the energy transitions section.

10547 4 41 100 55

Accept. We are noting the implementation gap as well as the NDCs emission gap to 1.5 or 2C.
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
10909 | 6 | 6 | 6 | 9 | Permitting regulations policies for renewable energies should never be more stringent, costly, designed for replacing a fossil-powered device (heating/vehicle/industry) by a renewables-powered device, than to replace the existing device by a renewables-powered device which is often considered as maintenance and does not require any permitting. ([Beat Brunner, Switzerland]) | Rejected. It is not clear to what phrase the comment is referring. And it seems to want to introduce a template for non-specific and overly specific language for an ES.
10911 | 6 | 6 | 6 | 9 | The text from page line 20-21 should go into the executive summary since it is a major change from AR5. The transition to a 1.5°C world by 2050 leaves almost no temporal leeway for in implementation, unless massive penetration of cheap climate-disaster-reducing technologies becomes possible. ([Beat Brunner, Switzerland]) | Taken into account, but this line should be addressed in chapter 2. The phrase in the introduction also builds on chapter 2.
10905 | 6 | 6 | 6 | 9 | Executive summary: the part that should be the most polished and easy to read and understood by non-scientific politicians and give them in their talks a tool for immediate actions. Proposal of introduction paragraph for executive summary: To limit global warming to 1.5°C, all countries must/should: 1. Accelerate and upscale massively sustainable development, energy transition, and climate mitigation and adaptation actions. 2. To do so, encourage, facilitate and mainstream sustainable development and clean and cheap energy transition. 3. All these measures will be much easier and much less costly if done immediately to aim limiting to 1.5°C than with 2.0°C. ([Beat Brunner, Switzerland]) | Rejected. Giving a policymaker to-do list would be introducing prescriptive language.
10906 | 6 | 8 | 6 | 9 | Executive summary layout: Should be made more appealing to read. Lots of similar-looking paragraphs, no graphs, same interligns, no sub-sections make it hard to read. ([Beat Brunner, Switzerland]) | Noted. We were told to use such a format.
10311 | 6 | 8 | 6 | 9 | ES needs really, maybe slightly too policy prescriptive in places. Care with superlatives needed and use of words such as significance ([Paris Forster, United Kingdom) of Great Britain and Northern Ireland] | Thank you, and we try to take the comments into account.
19316 | 6 | 8 | 6 | 15 | Well written executive summary. [Marco Moazzmi, Switzerland] | Thank you.
7899 | 6 | 2 | 6 | 12 | The implementation of sustainable, multifaceted, multi-disciplinary, multi-sector and cross-country and sectoral-climate mitigation and adaptation actions…. Current national pledges on mitigation and adaptation, even if fully implemented, are insufficient. The creativity of broad public-private-scientific partnerships and strategic engagement with private stakeholders would be decisive to implement and go beyond current ambition cost-effectively and in a manner which is sustainable, inclusive and resilient to changed political priorities, and which maintains a solid democratic legitimacy. [Yvonne POPROSTOVA, France] | Noted - Care has been taken to avoid policy prescriptive language.
5732 | 6 | 4 | 6 | 5 | Better use “sustainable development goals”, instead of initiatives which are not clearly defined. [Yong Yang, Switzerland] | Rejected. We have been assigned to look at sustainable development. A closer and more specific examination of the SDGs in the context of 1.5°C happens in chapter 5.
12274 | 6 | 4 | 6 | 6 | This first sentence sounds rather obscure to me. I hope the next draft can say something that is more concise that aids more new insight. Although well known, the first or second unison sentence would work better. [Jan Pukh快手, Norway] | Taken into account. We have strengthened the sentence to go beyond the obvious. We considered that stating that the NDC sentence without context would be too sudden.
5440 | 6 | 4 | 6 | 5 | It seems more appropriate to say… - integrated with sustainable development initiatives, facilitates the transition to a 1.5°C world. [Klaus Rudaryuni, Austria] | Taken into account. The language was indeed not excessively clear. It has been revised into “have been observed historically”.
6572 | 6 | 5 | 6 | 5 | Consider substituting ‘can’ by ‘is needed’. ‘Can’ seems a too vague word in the present conditions, because it does not say how much it can or it cannot… A more precise and blunt statement may be required. [J. David Tabares, Spain] | Taken into account. This sentence is an obvious but also political statement -> delete. If kept, why not add for balance that also industrialized countries will have large financial needs.
1105 | 6 | 6 | 6 | 20 | Meeting the temperature target does not really depend on adaptation - it is climate… [Rob Swart, Netherlands] | Rejected, but the reviewer is right that the sentence did not make sense. See response to comment 2227.
11055 | 6 | 20 | 6 | 21 | More specific about the expression “consider”- does this mean the necessary speed of change has been observed over longer periods of time (low-long) and larger geographical scales (where?) [Jakob Weischemann, Germany] | Taken into account, this language was indeed not excessively clear. It has been revised into “have been observed historically”.
2227 | 6 | 6 | 6 | 6 | It needs to be clarified how policies on adaptation influence how plausible it is that the long-term temperature target of the Paris Agreement is attained. [Kenneth Midtendist, Sweden] | Accepted. “and achieve its adaptation goals” added to the sentence.
16381 | 6 | 6 | 6 | 9 | I would like to suggest that the assessment needs to give on quantitative estimate of how adequate the present commitments are, namely that to achieve a maximum increase of 1.5-2°C, 80% of the emissions of CO2 and other GHGs would need to be phased out within about two decades (or whatever the number is, but not very far in the future), indicating that about all that has happened to date is for emissions to stop growing—a nice first step, but a long path ahead. [Michael MacCracken, United States of America] | Noted. This question is extensively discussed in chapter 2 ES.
1025 | 6 | 7 | 6 | 8 | It is described that “to strengthen the global response, national governments would need to significantly raise their level of ambition —… Whether or not governments would be able to raise their level of ambitions are real and serious concern. This chapter, in order to become more policy relevant, should search and refer to political economy papers discussing on this crucial point. [Mitsutsune Yamaguchi, Japan] | Taken into account - these aspects are now covered in Section 4.4.3 and also later on in the Executive Summary of the SCD
5730 | 6 | 6 | 6 | 10 | Please consider to remove the quotation signs. [Björn Christophersen, Norway] | Editor changed in SCD
1107 | 6 | 6 | 6 | 11 | Please consider to remove an obvious but superficial political statement —- “stable.” Why not add for balance that also industrialized countries will have large financial and technological challenges? [Rob Swart, Netherlands] | Accepted. Text is amended to reflect this point in the SCD executive summary
18788 | 6 | 9 | 6 | 11 | The references to finance in the Executive Summary should reflect an increased emphasis on shifting both public and private finance to be compatible with both low-carbon and climate resilient pathways, rather than just low-carbon for countries, this will involve ensuring that a wide range of investments that are not specific to climate, such as those in infrastructure, are sketched so they enable countries to pursue those pathways. For example, the findings in the report by the Global Commission on the Economy & Climate demonstrate the need for this shift. [David Waskow, United States of America] | Taken into account. Section 4.4.6 uses the GCEC report and other literature to discuss different investments. Text in the ES has been amended.
18821 | 6 | 9 | 6 | 11 | The references to finance in the Executive Summary should reflect an increased emphasis on shifting both public and private finance to be compatible with both low-carbon and climate resilient pathways, rather than just low-carbon for countries, this will involve ensuring that a wide range of investments that are not specific to climate, such as those in infrastructure, are sketched so they enable countries to pursue those pathways. For example, the findings in the report by the Global Commission on the Economy & Climate demonstrate the need for this shift. [David Waskow, United States of America] | Taken into account. Section 4.4.6 uses the GCEC report and other literature to discuss different investments. Text in the ES has been amended.
19704 | 6 | 9 | 6 | 11 | Without international support developing countries, particularly the Least developed countries will not be able to implement their NDCs and pursue 1.5 pathways. See research by the McKinsey Foundation in line below. [Bork Sam, Ireland] | Taken into account - covered in Cross-chapter box 4.1 on NDCs and added to the Executive Summary of the SCD
16382 | 6 | 9 | 6 | 9 | I would suggest there also needs to be a sentence in here about steps that developed countries must take. Perhaps even indicating that the investment of all nations needs to be comparable to the expenditures currently being devoted to national security, and this would be appropriate given the very significant threat being posed by the growing impacts of climate change. [Michael MacCracken, United States of America] | Rejected. There is insufficient basis for such a statement, in the chapter nor in the peer-reviewed literature.
5041 | 5 | 11 | 6 | 11 | A more precise and blunt statement may be required. [J. David Tabares, Spain] | Accepted. Text edited to reflect review.
1108 | 6 | 13 | 6 | 15 | What is the evidence that even 1.5 degrees requires “transformational adaptation”? This suggests the message that even under 1.5 degrees massive adaptation is required, so why bother about mitigation? [Rob Swart, Netherlands] | Taken into account. The new text gives further explanation, including that adaptation is even needed at 1C.
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
7517 | 6 | 13 | 6 | 13 | We think it is difficult to understand what 'adaptation imperatives' means. If it is the same as 'adaptation needs', please subtitle. [Miyuki Christophersen, Norway] | Accept. Text revised from adaptation imperatives to adaptation needs.
14060 | 6 | 13 | 6 | 13 | Transformative adaptation' should be defined, if it is the same as 'transformational adaptation', is definition consistent with other chapters? [Elvira Poltorka, Germany] | Accept. We are now using 'transformational adaptation' which is also defined in the IPCC AR5 WGII and SR 1.5 glossary (as a sub-term of adaptation).
7513 | 6 | 13 | 6 | 14 | What is transformative adaptation? [Andrew Harder, Netherlands] | Accept. We are now using 'transformational adaptation' which is also defined in the IPCC AR5 WGII and SR 1.5 glossary (as a sub-term of adaptation).
7558 | 6 | 13 | 6 | 14 | Transformative adaptation is never defined. See comment below on defining the term and the use of disruptive change. [Michael MacCracken, United States of America] | Accept. Text has been amended.
16383 | 6 | 13 | 6 | 14 | The type of phrasing and comparison, saying adaptation will be less at 1.5°C than 2°C, is fine, but needs to be accompanied by a more stronger statement of the adaptation challenges at 1.5°C—indeed indicating that adaptation will simply not be possible to a good number of impacts at 1.5°C (e.g. preventing existing coastal infrastructure and low lying islands, avoiding the impacts of significant biodiversity loss at the level of warming, shifting precipitation zones, growing risk of very extreme weather, exciting carbon and methane feedbacks, and more). The phrasing here just does not convey the risk the world is taking by allowing the global average to increase to 1.5°C, much less to stay there indefinitely as is implied in much of the analysis in this report. [Michael MacCracken, United States of America] | Taken into account. The text has been revised significantly for consistency and clarity of sight.
5733 | 6 | 13 | 6 | 19 | The key messages in the bold text and the elaboration in the plain text seem to be inconsistent. Also the meaning of the bold text is not clear. [Hong Yong, South Korea] | Taken into account. The text has been revised in the next paragraph.
7870 | 6 | 13 | 6 | 20 | While adaptation finance volumes have increased in qualitative terms starkly, qualitative gaps in resource distribution and effect as well as in current adaptation finance perish which in combination with ineffective monitoring mechanisms undermine transformative action. [Yana Popkostova, France] | Taken into account and take into account in the ES text.
5442 | 6 | 14 | 6 | 14 | It seems more appropriate to say... on vulnerable systems and regions across the world also in a 1.5°C world. [Klaus Rudolf, Austria] | Taken into account in the rewrites of the paragraph.
16384 | 6 | 16 | 6 | 15 | And it might be noted that at 1°C and just current emissions, a further warming of order 0.5°C is built into the system and the changes occurring (like loss of sea ice from shelves and glaciers and elevated sea level warming and ice are not merely at equilibrium with the current atmospheric composition) The sentence just does not convey the seriousness of the situation that the world has gotten itself into. [Michael MacCracken, United States of America] | Accept. The point of 1°C is included, the other points are part of the ES of chapter 3.
14061 | 6 | 16 | 6 | 17 | Chapter 1 also refers to community knowledge, local knowledge, traditional knowledge. Need consistency [Elvira Poltorka, Germany] | Accept. The text has been amended to include traditional and local knowledge systems. We choose to use ‘indigenous knowledge’ as opposed to ‘traditional’ because of the pejorative label of ‘traditional’ when applied to knowledge systems with its connotations of being static, archaic, and pre-modern knowledge.
19706 | 6 | 17 | 6 | 18 | Note that indigenous knowledge and community participation are also critical for mitigation. See examples of what can happen when the right to participation of local communities is not respected in mitigation action (wind, hydro, solar). Case studies available from the Human Rights and Business Resource Centre: https://business-humanrights.org/en/case-studies-renewable-energy [Tara Shine, Ireland] | Noted. Of course action can be effective without monitoring, but learning and water application, where appropriate, is less likely without it. Text revised to clarify that gaps in monitoring undermine the potential of adaptation/finance to be effective.
14062 | 6 | 18 | 6 | 19 | Refer here also to ‘maladaptation’ [Elvira Poltorka, Germany] | Accept. With a reference to cross-chapter box 4.3
918 | 6 | 21 | 4 | 22 | Did not find the statement to be properly substantiated in the text of the Chapter [Victor David, United States of America] | Noted. It is in section 4.2. But clarification is needed. See response to comment 599.
1109 | 6 | 21 | 6 | 22 | This doesn't seem to be true over long time spans and large areas (e.g. global), so add "for some areas during limited periods of time?" [Rob Swart, Netherlands] | See response to 959.
20319 | 6 | 21 | 6 | 22 | Statement not clear. In my view, a much more accelerated deployment of various low-carbon technologies is needed. [Ivar Salbu and Inge Karoline Thorsen, Norway] | Accept. See comment 959.
7074 | 6 | 21 | 6 | 22 | In the main text this statement is much more nuanced, it depends on the metric used [Andrew Harder, Netherlands] | Accept. See comment 959.
2228 | 6 | 21 | 6 | 22 | Since BECCS is an energy technology, the statement encompasses the BECCS deployment rates found in the modeling. This report does not explicitly analyze the rates of change in CDR based on historical observations. In fact, it does not refer to any historical observations at all that are relevant to BECCS, like e.g. experiences of nuclear power deployment. [Knut Mariussen, Norway] | Rejet. The reference for this statement is to section 4.2.2.1.
7997 | 6 | 21 | 6 | 22 | The rates of change in energy technology deployment found in the modeling of emission pathways for 1.5°C are consistent with those observed historically. This is not discussed at all in Section 4.3.2. It only say mention that solar energy and onshore wind energy are on track to reach 2°C pathways. [Michael MacCracken, United States of America] | Rejet. The reference for this statement is to section 4.2.2.1.
12275 | 6 | 21 | 6 | 23 | The first sentence here says consistent rates, but next sentence says scale is larger - and this is an essential difference. Does this mean that the first sentence applies for some sectors or regions only? And also for shorter horizons, I think. Some clarifications is needed here, I think. [Jan Puglisi, Norway] | Accept. See comment 959.
4495 | 6 | 21 | 6 | 27 | Disagree with this statement. The rate of deployment for 1.5°C exceeds all previous energy transitions, factoring in the time it takes to scale-up technologies. We also have to see them making the point of very large scale commercial-upgrade. This statement gives a misleading and incorrect view of the challenge ahead, as does much of Chapter 4. [Wilfried Maas, Netherlands] | Noted. We are certainly trying to give a fair and literature-based account of the challenging nature of limiting temperature rise to 1.5°C. This specific statement has been softened, see also responses to comment 959.
969 | 6 | 21 | 6 | 27 | top line statement here seems disconnected from chapter 2, fact 3 and the reality. Are these rates of change really consistent with those observed historically in a similar context and scale? [Victor David, United States of America] | Accept. The text has been amended to make the paragraph consistent, to clarify what is meant, and to reflect the underlying sections better.
7871 | 6 | 21 | 6 | 23 | While the rates of change in energy technology deployment found in the modeling of emission pathways for 1.5°C are consistent with those observed historically, the scale of the required energy, land and urban transitions is larger and requires strategic and consistent coordination across actors in a radical decoupling to avoid or avoid coincident changes observed in the past. This is critical because the success of simultaneous energy, land and urban transitions would ultimately depend on blended and multiple changes, accelerated innovation and effective policies and governance. The bottomline is that mitigation actions with the potential to stay below 1.5°C and adaptation options that allow for coping with the 1.5°C world are interlinked and this interlinkage has to be recognised across the institution, policy and governance-building entities. [Yana Popkostova, France] | Noted. We are assessing these options in the same sections for that reason in section 4.3. And we make the statement that they are related already in the ES - so not clear what precisely the suggested change is.
Saying "is larger" seems like a significant understatement. To stay below 1.5°C likely requires going to zero fossil fuel emissions within a couple of decades, and that would require changing over of order the source of supply for 80% of global energy. Suggesting this is just larger than hazy conveys the magnitude of the change that is needed. [Michael MacCracken, United States of America]

Revised. The point that the change made - e.g., from 100% sailing ships to almost 100% motorised - is that for international freight traffic - has been shown before, but the point here is that the size of the system amounts of people, buildings, industrial production, installations, economic value - is much greater.

Jurisdictions in this sentence might be challenging to understand. Is it an option to delete jurisdictions around the world, or replace it with systems? [Elvira Poloczanska, Germany]

Revised. This is explained in the paragraph and paragraphs that follow.

In solar energy, wind energy and energy storage systems, a transformation seems to be underway. China has been adding a tremendous amount of capacity to the grid. [Jason Denov, Canada]

Revised. Although some countries have been adding some nuclear capacity, the current coal developments and capacity additions of nuclear cannot possibly be compared to those of wind and solar PV.

The energy transition is taking place in many sectors and jurisdictions across the world at various speeds and intensity, but the pace in energy-intensive industries, waste management and international transport is a progressing at a slower pace overall. [Yana POKKOSTOVA, France]

Revised. Not sure how this edit would improve things.

We are all part of Nature and all hold a stake in its future. We can not assume Nature, water, land air etc to be resources and services. Nature and ecosystems should be protected for its intrinsic value. [Barbara Norman, Australia]

Revised. Taken into account, though the comment can be seen as prescribing a vision of nature that may not be compatible with the existing view of nature that many of us feel.

The term ecosystem health is delicate language that needs to be used with care. It is a useful and relatively well-defined metric for representing the complex of ecosystem attributes that make up an ecosystem's healthy status. [Charlie Smil, Canada]

Revised. This would make the text more prescriptive.

Accept. The SOD includes a section in the ES that explicitly goes into combining mitigation and adaptation options and their pros and cons.

Accept. This is discussed in the next paragraphs.

Specify what kind of barriers building sector faces (technical, social, economic, infrastructure, whatever) [Miriam Solera Ureña, Germany]

Revised. This is discussed in the next paragraphs.

What barriers? This statement is rather vague. [Elvira Poloczanska, Germany]

Revised. Not sure how this edit would improve things.

The rapid, systemic transitions in urban areas will be a defining element in an accelerated transition to a 1.5°C world. In general, the chapter lacks specificity on urban adaptation and mitigation actions, specifically in terms of buildings. See below. [Westphal Michael, United States of America]

Revised. Although the chapter lacks specificity on urban adaptation and mitigation actions, specifically in terms of buildings, a section in the ES that explicitly goes into combining mitigation and adaptation options is included.

Saying "is larger" seems like a significant understatement. To stay below 1.5°C likely requires going to zero fossil fuel emissions within a couple of decades, and that would require changing over of order the source of supply for 80% of global energy. Suggesting this is just larger than hazy conveys the magnitude of the change that is needed. [Michael MacCracken, United States of America]

Revised. The point that the change made - e.g., from 100% sailing ships to almost 100% motorised - is that for international freight traffic - has been shown before, but the point here is that the size of the system amounts of people, buildings, industrial production, installations, economic value - is much greater.

We are all part of Nature and all hold a stake in its future. We can not assume Nature, water, land air etc to be resources and services. Nature and ecosystems should be protected for its intrinsic value. [Barbara Norman, Australia]

Revised. Taken into account, though the comment can be seen as prescribing a vision of nature that may not be shared universally. In any case, the text is changed to focus on adaptation options more and less on the general statement.
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>7874</td>
<td>6</td>
<td>55</td>
<td>6</td>
<td>55</td>
<td>...be overcome. (4.3.4) The Food-Energy-Water nexus issue should increasingly be considered as such: a nexus, and water, energy and water management integrated, thereof moving away from the piecemeal approaches to governance in these sectors to a holistically integrated Food-Energy-Water collective strategy that builds management and governance methodologies and tools from a paradigm of compliance with the decarbonisation. SDSs and 1.5 pathways ambitions. Only an integrated PEW governance through a prem of 1.5 pathway could bolster a workable and effective energy transition governance framework.</td>
<td>Reject the addition because of prescriptive language, absence of a clear reference for this in the chapter, and lack of space.</td>
</tr>
<tr>
<td>10212</td>
<td>7</td>
<td>1</td>
<td>7</td>
<td>12</td>
<td>Regulation on halib carbon could curb BC without transformation - so don't get laid back melt. Also unmitigated this strong as cutting NUC and SOD might just be as helpful (Paul Foster, United Kingdom of Great Britain and Northern Ireland)</td>
<td>Taken into account. The point is that if the transition in 4.3 succeed - and they are all needed for 1.5 - SLCPs would be reduced automatically.</td>
</tr>
<tr>
<td>4853</td>
<td>7</td>
<td>1</td>
<td>7</td>
<td>13</td>
<td>Include a separate key message on the dependence on rapid start of the CCS morass , greta's role for Fossil CCS and BECCS in the 1.5 scenarios. (Bjorn Wiaan, Norway)</td>
<td>Accept (partially). Sentence on CCS included in the paragraph on energy transition (which is the section where CCS is discussed). However, the point that BECCS depends on it is not made specifically - constraints for its feasibility are named.</td>
</tr>
<tr>
<td>19290</td>
<td>7</td>
<td>1</td>
<td>7</td>
<td>7</td>
<td>I am not sure to understand [the] structure of this paragraph - why are measures to reduce short-lived pollutants and options to remove the CO2 from the atmosphere presented together? (Charlotte Valle, France)</td>
<td>Accept. Separated in the new version.</td>
</tr>
<tr>
<td>4791</td>
<td>7</td>
<td>1</td>
<td>7</td>
<td>13</td>
<td>There is a degree of repetition in this paragraph. Rather than repeating generic observations (i.e. that there are constraints), be specific. List the primary opportunities to remove CO2 and identify the main constraints. (Stewart Liddle, Australia)</td>
<td>Noted. Fair point, but this paragraph is not about the political economy of climate change mitigation. The picture, by the way, seems to be shifting somewhat as impacts are becoming fiercer and more widespread.</td>
</tr>
<tr>
<td>11460</td>
<td>7</td>
<td>1</td>
<td>7</td>
<td>13</td>
<td>I would suggest that there are now, potentially, cost-effective (relative to incremental impact costs) approaches emerging for removing CO2 from the atmosphere that could be significantly scaled up. For this reason, I will suggest that at least the major constraints measured here be enumerated in the sentence--and perhaps some indications of prospect should be noted. [Michael MacCracken, United States of America]</td>
<td>Taken into account. The non-void test in this paragraph does exactly that. Unfortunately in the ES, we don't have too much room to go into more detail.</td>
</tr>
<tr>
<td>16307</td>
<td>7</td>
<td>1</td>
<td>7</td>
<td>7</td>
<td>Include a separate key message on the dependence on rapid start of the CCS morass , greta's role for Fossil CCS and BECCS in the 1.5 scenarios. (Bjorn Wiaan, Norway)</td>
<td>Accept (partially). Sentence on CCS included in the paragraph on energy transition (which is the section where CCS is discussed). However, the point that BECCS depends on it is not made specifically - constraints for its feasibility are named.</td>
</tr>
<tr>
<td>970</td>
<td>7</td>
<td>1</td>
<td>7</td>
<td>4</td>
<td>I suggest that we rearrange the findings on CER from those on SLPs... and give the CDF attention to CDR (BECCS morass) in chapter 2 or have just a single sentence on this option seems too thin. There is a big literature on feasibility under 2 degree scenarios; that should be addressed here or in chapter 2, with governance here. (Vidar Davidsen, United States of America)</td>
<td>Accept. CDR and SLCPs separated. In the paragraph on CDR, all that we feel should be said on CDR is said.</td>
</tr>
<tr>
<td>7520</td>
<td>7</td>
<td>2</td>
<td>7</td>
<td>8</td>
<td>Please consider making the description of SLCPs to a separate paragraph as it does not seem to fit here where you talk about CDF. Also please do not refer to report chapters in headline statements. (Bjorn Wiaan, Norway)</td>
<td>Accept. Paragraphs moved.</td>
</tr>
<tr>
<td>5916</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>4</td>
<td>Suggest changing the sentence to &quot;As a consequence measures to reduce short-lived climate pollutants (SLCPs) must be implemented.&quot; [Age [Stangeland, Norway]</td>
<td>Reject. This is not only a prescriptive statement. It changes the meaning.</td>
</tr>
<tr>
<td>7876</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>4</td>
<td>Measures to reduce SLCPs will be conditional on the success of the land, energy and urban transitions. (Yana POPKOSTOVA, France)</td>
<td>Accept. This is implemented.</td>
</tr>
<tr>
<td>18769</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>8</td>
<td>The discussion of SLCPs in the Executive Summary should be separated from the discussion of net removal of CO2. (Bjorn Wiaan, United States of America)</td>
<td>Accept. This is implemented.</td>
</tr>
<tr>
<td>18790</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>8</td>
<td>The discussion of SLCPs in the Executive Summary should address the role of SLCPs in driving temperature past the 1.5C threshold in the near-term and the options for addressing these pollutants. (David Wilcox, United States of America)</td>
<td>Accept. Most of what this comment asks for is done in chapter 2. The options are in this chapter and are discussed in section 4.3.7.</td>
</tr>
<tr>
<td>18822</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>8</td>
<td>The discussion of SLCPs in the Executive Summary should be separated from the discussion of net removal of CO2. (Bjorn Wiaan, United States of America)</td>
<td>Accept. This is implemented.</td>
</tr>
<tr>
<td>3983</td>
<td>7</td>
<td>4</td>
<td>7</td>
<td>6</td>
<td>Strongly disagrees that these options have &quot;unlimited cockiness&quot;. Given that some SLCPs have high GWP's, they will be pursued purely for climate reasons. Or to make money, particularly on HFCs, the UNFCCC found that there can be quite perverse incentives - UNFCCC 2009. Issues arising from the implementation of potential project activities under the clean development mechanism. The case of incrination of HFC-23 waste streams from HCFC-23 production. FCC/COP/2009/1. Bonn. United Nations Framework Convention on Climate Change. <a href="http://unfccc.int/9872/isso/unfccc2009/5101.pdf">http://unfccc.int/9872/isso/unfccc2009/5101.pdf</a>. A point you would have to explain why benefit for SLCPs are &quot;unrivalled cobenefits&quot; compared to energy efficiency, which saves poor households money. Or co-benefits of reducing Nists SOx PM MVOCs. These have large health co-benefits. (Bjorn Wiaan, Norway)</td>
<td>Accept, but because of an omission on our side, this was not implemented in the SOI. We will take this into account into the following rounds.</td>
</tr>
<tr>
<td>16388</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>Do you really mean &quot;fast emissions reductions&quot; or instead &quot;fast response to emissions reductions&quot; due to their relatively short atmospheric lifetimes? (Michael MacCracken, United States of America)</td>
<td>See response at 3277.</td>
</tr>
<tr>
<td>12277</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>Yes. Fast emission reductions. Do you mean easy and quick to implement? If so, yes that clearly (since it is often pointed to fast responses in the atmosphere when SLCP mitigation is discussed). (Jan Fuglestvedt, Norway)</td>
<td>Accept, but because of an omission on our side, this was not implemented in the SOI. We will take this into account into the following rounds.</td>
</tr>
<tr>
<td>6196</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>No strong a claim here really about political feasibility. Suggest changing to 'may enhance'. It is possible that producing such other benefits might be overcome.</td>
<td>Accept, risks and impacts are addressed explicitly in the SOD ES.</td>
</tr>
<tr>
<td>11056</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>11</td>
<td>Mention risks and benefits, e.g. by saying [...] I need to consider, with both regard to their political potential and with regard to their sustainability impacts.</td>
<td>Accept. Risks and impacts are addressed explicitly in the SOI ES.</td>
</tr>
<tr>
<td>2737</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>Are the emissions options actually feasible at the scale required? This is not an area of expertise of mine, but I have read publications suggesting the opposite, that we do not yet know enough to state this. (Egan Larkan et al. 2017 [Energy Urgency, South Africa])</td>
<td>Noted. They are considered technically feasible but we note lots of other constraints that affect the issue.</td>
</tr>
<tr>
<td>21172</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>IPCC AR5 to include ecosystem restoration more generally [David Cooper, Canada]</td>
<td>Reject. We base this statement on the outcomes of the meeting in chapter 2, which takes into account AR5 but not ecosystem restoration.</td>
</tr>
<tr>
<td>15687</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>13</td>
<td>BECCS is not proven to be technically feasible. See <a href="http://www.ibisworld.com/us/2015/12/mccs-report.html">http://www.ibisworld.com/us/2015/12/mccs-report.html</a> [Elien Dafo, Philippines]</td>
<td>Accept. This is not proven to be technically feasible. The reference provided is not a peer-reviewed source.</td>
</tr>
<tr>
<td>15688</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>13</td>
<td>Here the mentioned options &quot;NEET&quot; to be considered. There are many other options,all of these just unproven technological technologies [Elien Dafo, Philippines]</td>
<td>Accept. Prescriptive language is revised.</td>
</tr>
<tr>
<td>15440</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>13</td>
<td>BECCS is not proven to be technically feasible. See <a href="http://www.ibisworld.com/us/2015/12/mccs-report.html">http://www.ibisworld.com/us/2015/12/mccs-report.html</a> [Elien Dafo, Philippines]</td>
<td>Reject. We are not saying that its proven technically feasible. The reference provided is not a peer-reviewed source.</td>
</tr>
</tbody>
</table>
### Comment Review and Responses - Chapter 4

<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>14118</td>
<td>7</td>
<td>9</td>
<td>7</td>
<td>9</td>
<td>Please use another acronym than AR, which is assessment report in the IPCC context [Elvira Poloczanska, Germany]</td>
<td>Taken into account - to repair this, the convention was adopted to use AR – when standing for Assessment Report – only in conjunction with the number of the report, i.e. in the former section. 4.3.6 “AR”. We hope this avoids the confusion validity pointed out here. We also don’t refer to the abbreviations in the ES.</td>
</tr>
<tr>
<td>15389</td>
<td>7</td>
<td>11</td>
<td>7</td>
<td>11</td>
<td>With respect to “aerow high” – with respect to what? Yes, much less expensive now to reduce emissions, but as the costs of those rise and the costs of impacts increase, at what point does high changeover to feasible? [Michael MacCracken, United States of America]</td>
<td>Accept. See comment 15845</td>
</tr>
<tr>
<td>15317</td>
<td>7</td>
<td>11</td>
<td>7</td>
<td>11</td>
<td>I suggest calling it DACCS: Direct Air Capture with Carbon dioxide Storage [Marco Mazzotti, Switzerland]</td>
<td>Noted. Abbreviation removed here. We are using both DACS and DACCCS in the report (see Glossary in SOCD).</td>
</tr>
<tr>
<td>7871</td>
<td>7</td>
<td>11</td>
<td>7</td>
<td>11</td>
<td>... costs of direct air capture and storage remain high. [Yoana POPKOSTOVA, France]</td>
<td>Noted. Text amended which makes this comment obsolete.</td>
</tr>
<tr>
<td>9409</td>
<td>7</td>
<td>11</td>
<td>7</td>
<td>11</td>
<td>Say DACCS (no DACS) and add “carbon” for direct air carbon capture and storage. So it will be easy to grasp that it is associated with CCS. There are different categories of CCS: fossil CCS, industry CCS (terminologies used in Chapter 2, BECCS and DACCS, depending on where the CO2 is captured from. [Isabelle Czernichowski-Lauriol, France]</td>
<td>Noted. Abbreviation removed here.</td>
</tr>
<tr>
<td>19291</td>
<td>7</td>
<td>11</td>
<td>7</td>
<td>13</td>
<td>The statement “need to be considered” could be specified. [Charlotte Vailles, France]</td>
<td>Taken into account. This statement is prescriptive and was removed.</td>
</tr>
<tr>
<td>21173</td>
<td>7</td>
<td>11</td>
<td>7</td>
<td>13</td>
<td>need to distinguish between (GCS, blue carbon) and ocean fertilisation. The latter is regulated by international law London convention. [David Cooper, Canada]</td>
<td>Noted. Text revised makes this comment obsolete.</td>
</tr>
<tr>
<td>18663</td>
<td>7</td>
<td>12</td>
<td>7</td>
<td>12</td>
<td>What is ocean weathering? [Wilfran Moufouma Okia, France]</td>
<td>Taken into account. Amended to remove ocean weathering and only keep terrestrial weathering. See chapter for explanation (4.3.6)</td>
</tr>
<tr>
<td>543</td>
<td>7</td>
<td>13</td>
<td>7</td>
<td>13</td>
<td>... need to be considered: I would suggest to change in “... are options but have side effects as well. For example, biochar results in air pollution so creates a health problem. [Mark Jacobson, United States of America]</td>
<td>Accept, text revised significantly to take into account this and other comments.</td>
</tr>
<tr>
<td>7078</td>
<td>7</td>
<td>13</td>
<td>7</td>
<td>13</td>
<td>... ocean iron fertilisation, and other greenhouse gas removal (GGR) techniques need to be evaluated. [4.3.6] [Yoana POPKOSTOVA, France]</td>
<td>Noted. Text amended which makes this comment obsolete.</td>
</tr>
<tr>
<td>12279</td>
<td>7</td>
<td>15</td>
<td></td>
<td></td>
<td>The paragraph conveys uncertainty with concern. We could interpret the GeoMIP model results as showing that the uncertainty level is rather low for low-deployment scenarios. On the other hand, people are concerned about slightest deployment of SRM. [Masaaki Sugiyama, Japan]</td>
<td>Accept. We agree and have amended the text to “The uncertainties surrounding various solar radiation management measures, hereafter called radiation modification measures (RMMs), including technological immaturity, lack of physical understanding, inability to limit global warming, and ability to scale, govern and legitimise, constrain their responsible implementation.”</td>
</tr>
<tr>
<td>9897</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>15</td>
<td>The paragraph conveys uncertainty with concern. We could interpret the GeoMIP model results as showing that the uncertainty level is rather low for low-deployment scenarios. On the other hand, people are concerned about slightest deployment of SRM. [Masaaki Sugiyama, Japan]</td>
<td>Accept. We agree and have amended the text to “The uncertainties surrounding various solar radiation management measures, hereafter called radiation modification measures (RMMs), including technological immaturity, lack of physical understanding, inability to limit global warming, and ability to scale, govern and legitimise, constrain their responsible implementation.”</td>
</tr>
<tr>
<td>20490</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>18</td>
<td>In Chapter 3 SAI is used for Stratospheric Aerosol Injection, not aerosol injection that is the more normal usage. More importantly, there are various-along statements in this paragraph which are not evidenced (it is also, oddly, the only para in the executive summary that does not reference specific parts of the chapter as the foundation for its assertions). It seems a priori unlikely that SAI could not compensate for part of the temperature rise: all studies show SIRM having some negative effect on temperature. Regardles of whether it could in principle do so, it is unnecessary, indeed varying on impractical, to ask whether SIRM could compensate for all the temperature rise: no one is suggesting that it should. Current discussions of SIRM by people who might be seen as proponents universally stress the need for it to complement, not replace, emissions reduction. It is true that there are concerns about research in SIRM (of which there is, as it happens, very little) diverting political attention. There are also concerns about the level of research into SIRM being insufficient (see eg Shepherd 2009). Without any attempt to assess the relative merits of these concerns, why include one but not the other? If it is a true that there are moral hazard issues with SIRM, there are also moral hazard issues with CIRM. [Jane Fedler, Norway]</td>
<td>Accept. See responses to comments 10213 and 3068. For the other parts, text has been revised.</td>
</tr>
<tr>
<td>4395</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>18</td>
<td>This is not true. While no question there are many issues, the analogy with large volcanic explosions give essentially 100% certainty that SAI could reduce global mean temperatures by at least some amount. Agreement that conclusion is unclear for MCB. [Douglas MacMartin, United States of America]</td>
<td>Accept. See response to comment 10213</td>
</tr>
<tr>
<td>1028</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>22</td>
<td>By reading this paragraph, authors seem to stress the controversy of SIRM. I share the same view. It should be treated with caution. However, as discussed in Box 4.12 in pp 81-85, current NDCs are not on track to 1.5 (and even) 2 degree target. If exceeding these thresholds is deemed to be “harmful” in the context of the article 2 of the UNFCCC, we have to avoid those situations by all means. Here we have to compare risks of climate change exceeding 1.5 or 2 degree and still unknown risks of SIRM. This risk-risk trade-off of thinking should be inserted here. [Michaute Yamaguchi, Japan]</td>
<td>Noted. It goes too far to discuss this in the ES, but we will take it into account in the x-chapter box.</td>
</tr>
<tr>
<td>5444</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>22</td>
<td>It seems important to mention also risks associated with SIRM, including the need to deploy for the lifetime of CO2 in the atmosphere - which is in the range of several millennia. It would be important to stress that the IPCC made a focus on those scenarios that make sense in the context of a risk management approach. Therefore, scenarios that address climate change risks but enhance other risks in an uncontrollable manner, had not been further considered. The usefulness and adequacy of a risk management approach has already been communicated in AR4 and AR5. [Klaus Rademaka, Austria]</td>
<td>Accept. Point taken into account in the new paragraph.</td>
</tr>
<tr>
<td>11862</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>22</td>
<td>The paragraph on SIRM in the Executive Summary could be cleaner. For instance, it says that SIRM could not compensate for temperature rise as a technical matter (which seems false, at least for moderate temperature increases), or that it would face social feasibility constraints in doing so (which seems true). And the explanation of the moral hazard could be clearer. [David Morrow, United States of America]</td>
<td>Accept. Paragraph revised completely, though the point on moral/hazard is actually contested and therefore not included here.</td>
</tr>
<tr>
<td>Comment No</td>
<td>From Page</td>
<td>From Line</td>
<td>To Page</td>
<td>To Line</td>
<td>Comment</td>
<td>Response</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-----------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>3694</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>22</td>
<td>Suggest that governance challenges posed by SRM are addressed in this para. I see the need for para-gove into governance, but there are specific challenges of SRM - which your last sentence hints at [Harald Winter, South Africa]</td>
<td>Accept - We agree and have amended the text to &quot;The uncertainties surrounding various solar radiation management measures, henceforth called radiation modification measures (RMMs), including technological immaturity, lack of physical understanding, efficiency to limit global warming, and ability to scale, govern and legitimise, constrain their responsible implementation.&quot;</td>
</tr>
<tr>
<td>10213</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>22</td>
<td>Why don't SRM account for all temp-rea and what temperature rea do you refer to? I think a few of mirrors can go to high Win-2 [Pera Forster, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accept. Text revised to modify this statement.</td>
</tr>
<tr>
<td>752</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>22</td>
<td>There is no forward citations for this paragraph [??? meaning which is discussed in Box 4.13 and section 4.3.7 [Mikael Kom, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accept. Apologies for the omission to refer to the appropriate sections. Done in the SOD.</td>
</tr>
<tr>
<td>19707</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>22</td>
<td>Explain why there is a particular focus on SRM [Tara Shire, Ireland]</td>
<td>Noted. SRM is only one of the many paragraphs in this chapter and is therefore represented in the ES. We have in the SOD reduced the emphasis by shortening the text in both the chapter and the exciting box.</td>
</tr>
<tr>
<td>3065</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>22</td>
<td>Striking options are voiced about SRM in the summary without supporting chapters/sections for reference. I suggest you reference 4.3.7 and especially Box 4.13, especially regards to ocean acidification and potential ozone damage [Christophe Barale, Canada]</td>
<td>Accept. Apologies for the omission to refer to the appropriate sections. Done in the SOD.</td>
</tr>
<tr>
<td>18594</td>
<td>7</td>
<td>17</td>
<td>7</td>
<td>17</td>
<td>arterial injection [Wilfran Moufouma Okia, France]</td>
<td>Accept. Term has been removed from the ES.</td>
</tr>
<tr>
<td>4395</td>
<td>7</td>
<td>18</td>
<td>7</td>
<td>18</td>
<td>What planned research being referred to here? [Is there any?] [Douglas MacMartin, United States of America]</td>
<td>Taken into account. Statement removed.</td>
</tr>
<tr>
<td>7879</td>
<td>7</td>
<td>19</td>
<td>7</td>
<td>20</td>
<td>- temperature rea. SRM could potentially also divert political attention away from conventional mitigation, and this create a moral hazard around accelerating implementation of mitigation options and create controversy for reasons of justice, equity and ethics. [Yana POPKOSTOVA, France]</td>
<td>Taken into account. Text in ES is significantly shortened and the statement is removed.</td>
</tr>
<tr>
<td>16392</td>
<td>7</td>
<td>18</td>
<td>7</td>
<td>20</td>
<td>The statement is quite one-sided - there have also been a number of studies showing no effect and even that the prospect of SRM might help to drive greater mitigation. In that the level of warming that would really help to moderate major impacts is likely roughly 0.5°C so that we are already over it, there is a need in my view to be taking all actions possible to get back to a lower temperature increase in order to avoid a range of irreversible changes and commitments to long-term sea level rise, etc. In any case, the next question is whether using SRM to counteract the overshooting of a particular temperature level would lead to a better or worse outcome than without SRM. Much of current research has been focused on using SRM as a sudden, emergency response to very large and unacceptable outcomes whereas what would make much more sense is to gradually ramping up SRM to limit future warming and gradually pull back toward below 0.5°C, phasing it out as not only emissions come down but as CDR is phased up to remove the excess CO2 that has been emitted. [Michael MacCracken, United States of America]</td>
<td>Taken into account. Text in ES is significantly shortened and the statement is removed.</td>
</tr>
<tr>
<td>16390</td>
<td>7</td>
<td>20</td>
<td>7</td>
<td>20</td>
<td>This sentence seems quite problematic. The question that I think is appropriate to be assessed is whether the world’s nations would be better off having the GHG effect without SRM versus the GHG effect partially offset by SRM. How is it that the GHG effect alone would not take much greater issues of &quot;justice, equity and ethics&quot; that for SRM, given that virtually all plausible SRM implementations would bring the climate departures toward the baseline, unaltered situation. All SRM researchers favor as much as possible and generally view SRM as a supplement to and not a substitute for mitigation, and use of SRM as a way to shave off potential oversteps of temperature levels that are causing unacceptable impacts (this report seems to consider that level as 1.5°C, considering the temperature increase above which quite serious impacts become evident or were committed to, a level of about 0.5°C would seem a more appropriate choice (as Hansen et al. have documented). So, with SRM bringing the climate back toward its present or earlier state, generally within the range of current natural variability, it is a more serious than allowing GHGs to take the temperature to well above the level where there are severe impacts occurring? I just do not accept this explanation. [Michael MacCracken, United States of America]</td>
<td>Accept. Text revised as it is prescriptive.</td>
</tr>
<tr>
<td>919</td>
<td>7</td>
<td>20</td>
<td>7</td>
<td>21</td>
<td>It is also environmentally naïve. [David Infield, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accept. Text added.</td>
</tr>
<tr>
<td>14066</td>
<td>7</td>
<td>21</td>
<td>7</td>
<td>21</td>
<td>ALL options have ethical implications, not just SRM. This is not stated in Executive Summary [Elvira Poloczanska, Germany]</td>
<td>Taken into account. Statement removed.</td>
</tr>
<tr>
<td>12278</td>
<td>7</td>
<td>21</td>
<td>7</td>
<td>21</td>
<td>I think &quot;governance&quot; should be mentioned here as well. [Jan Fuglestvedt, Norway]</td>
<td>Accept. Text has been revised to balance this as the literature on ethics around SRM is so strong</td>
</tr>
<tr>
<td>16391</td>
<td>7</td>
<td>21</td>
<td>7</td>
<td>22</td>
<td>This sentence is not only quite speculative, but not at all clearly the case. As the IPCC radiative forcing approach suggests, reducing the radiative forcing over any significant region (such as via sulfate aerosols, tropospheric ozone) has a tendency to reduce overall global warming, which would be likely to be beneficial to all (given that warming is generally deleterious to everyone). If some particular country wants to make the effort to cool the global climate, how would this be seriously harmful to others. Now, it could be that a nation might try to exert a regional influence to favor only its region, but it is interesting that this report does not recognize the fact that such regional influences are even possible (were they to be doing this, then we could be researching the potential to moderate regional impacts as I have suggested in a paper, see, for example, MacCracken, M.C., 2016. The rationale for accelerating regionally focused climate intervention research, Earth’s Future 4, 649-657, doi:10.1002/2016EF000450). I just do not see how this statement can thus be justified, much as unilateral action would be less preferable to multilaterally planned actions. [Michael MacCracken, United States of America]</td>
<td>Reject. It is uncertain whether such an intervention would be beneficial to all. Moreover, in defence of the sentence, it does not say that the unilateral action would be done in order to inflict harm on others. In any case, the sentence is removed in the next version.</td>
</tr>
<tr>
<td>21174</td>
<td>7</td>
<td>21</td>
<td>7</td>
<td>22</td>
<td>and geopolitically infeasible [David Cooper, Canada]</td>
<td>Taken into account. We are referring to the ability to govern in the chapeau of the new para on SRM.</td>
</tr>
<tr>
<td>9985</td>
<td>7</td>
<td>21</td>
<td>7</td>
<td>22</td>
<td>Moriyama et al. (2016) used in the main text) show that it is rather difficult for stakeholders to conduct SRM unilaterally (but it is still easy for major powers to do it unilaterally). [Makoto Sugiyama, Japan]</td>
<td>Accept. Text on unilateral action is removed.</td>
</tr>
<tr>
<td>1113</td>
<td>7</td>
<td>22</td>
<td>7</td>
<td>22</td>
<td>This sentence contradicts itself. If a single country can act, it is not infeasible in any way. Maybe undesirable for other countries. [Rob Swart, Netherlands]</td>
<td>Accept. Sentence removed.</td>
</tr>
<tr>
<td>13301</td>
<td>7</td>
<td>22</td>
<td>7</td>
<td>22</td>
<td>I suggest inserting &quot;politically&quot; before &quot;infeasible&quot;. [Jan Fuglestvedt, Norway]</td>
<td>Taken into account. In the assessment framework, we include political feasibility under institutional feasibility. This is the term that is mentioned in the ES of the SOD.</td>
</tr>
<tr>
<td>5943</td>
<td>7</td>
<td>22</td>
<td>7</td>
<td>22</td>
<td>It is suggested to substitute &quot;geographies&quot; by &quot;regions&quot;. [Bojan Rudnakic, Austria]</td>
<td>Noted. This sentence has been edited out, making the comment obsolete.</td>
</tr>
<tr>
<td>7880</td>
<td>7</td>
<td>22</td>
<td>7</td>
<td>22</td>
<td>The last sentence is very important and an additional phrase is needed here in the executive summary and at least a paragraph in the expanded text below on why self-interest-driven action could impact adversely other geographies - how it will be done, why a statement needs to be supported by arguments and facts, otherwise it stays completely unscientifically-wise. [Yana POPKOSTOVA, France]</td>
<td>Noted. We have removed this sentence although we have retained the potential social infeasibility</td>
</tr>
<tr>
<td>14067</td>
<td>7</td>
<td>22</td>
<td>7</td>
<td>22</td>
<td>Socially unacceptable rather than infeasible? [Elvira Poloczanska, Germany]</td>
<td>Reject. We use the social feasibility as a term in our feasibility assessment framework.</td>
</tr>
<tr>
<td>Comment No</td>
<td>From Page</td>
<td>From Line</td>
<td>To Page</td>
<td>To Line</td>
<td>Comment</td>
<td>Response</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-----------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>7640</td>
<td>7</td>
<td>24</td>
<td></td>
<td></td>
<td>Political leadership has multiple effects including influencing government climate policies and influencing public attitudes to climate change. This point is present in the existing draft. It is an important point, but could be added here. Further evidence for this is suggested for the main body of the report in my subsequent comments. [Conor Little, Denmark]</td>
<td>Accept. This point is made in the SOD ES.</td>
</tr>
<tr>
<td>10214</td>
<td>7</td>
<td>24</td>
<td></td>
<td></td>
<td>Would ‘fully’illicit prosecution’ [Piero Fornaciari, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accept. Revised to may.</td>
</tr>
<tr>
<td>12880</td>
<td>7</td>
<td>24</td>
<td></td>
<td></td>
<td>1.5°C consistent world is not precise, although I think I understand what you mean. Would be good with an improved wording. [Jan Fuglestvedt, Norway]</td>
<td>Accept. Text changed in SOD ES (1.5 compatible).</td>
</tr>
<tr>
<td>7881</td>
<td>7</td>
<td>25</td>
<td></td>
<td></td>
<td>Governance in a 1.5°C consistent world must be able to create an enabling environment for policy and technology options, scientific innovation and commercialisation, behavioural changes and innovation. [Yana PIPKOSTOVA, France]</td>
<td>Noted. The addendum is already implied in “innovation”.</td>
</tr>
<tr>
<td>20246</td>
<td>7</td>
<td>28</td>
<td></td>
<td></td>
<td>My comments below will address the knowledge gap between the audience of the report and the public. My focus is on how the global museums sector comprising 55,000 museums in 203 countries can contribute to facilitating greater public awareness and improved education. [Moritz Rees, Norway]</td>
<td>Noted.</td>
</tr>
<tr>
<td>15895</td>
<td>7</td>
<td>24</td>
<td>7</td>
<td>30</td>
<td>Sounds policy prescriptive – use of the word should [Witold Motycka, Ckaz, France]</td>
<td>Accept. See response to comment 1229.</td>
</tr>
<tr>
<td>18792</td>
<td>7</td>
<td>24</td>
<td></td>
<td></td>
<td>Countershadowed policies should also include the incorporation and integration of the Sustainable Development Goals as part of the cooperation and coherence required in order to achieve the necessary enabling environment, particularly for IPSI referenced in Chapter 2 of the 1.5°C Special Report [David Waker, United States of America]</td>
<td>Noted - Taken into account in Ch 5.</td>
</tr>
<tr>
<td>18825</td>
<td>7</td>
<td>24</td>
<td></td>
<td></td>
<td>Countershadowed policies should also include the incorporation and integration of the Sustainable Development Goals as part of the cooperation and coherence required in order to achieve the necessary enabling environment, particularly for IPSI referenced in Chapter 2 of the 1.5°C Special Report. [David Waker, United States of America]</td>
<td>Noted - Taken into account in Ch 5.</td>
</tr>
<tr>
<td>14961</td>
<td>7</td>
<td>24</td>
<td></td>
<td></td>
<td>Would be helpful here to bring in private sector component, e.g., role of governance in facilitating private sector action, role of private sector in utilizing/implementing governance mechanisms [Farhan Akhtar, United States of America]</td>
<td>Accept. We have included a reference to non-state actors and refer to industry.</td>
</tr>
<tr>
<td>15708</td>
<td>7</td>
<td>24</td>
<td>7</td>
<td>30</td>
<td>The application of a rights-based approach and rights informed climate action is missing [Tanya Shaw, Ireland]</td>
<td>Noted. This is achieved in Chapter 3.</td>
</tr>
<tr>
<td>6197</td>
<td>7</td>
<td>26</td>
<td></td>
<td></td>
<td>The may be discussed explicitly below, but what the term “accountable multilevel governance” means is far from obvious. Part of the point of thinking about governance in multilevel terms is that it highlights that there is neither a single aisle of governance, nor a single community to which such governance is accountable [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Noted - Taken into account. The specific text suggestion is not adopted but “alignment of government and business and industry,” after “equity-enhancing financial institutions,” is inserted.</td>
</tr>
<tr>
<td>6573</td>
<td>7</td>
<td>26</td>
<td></td>
<td></td>
<td>Consider replacing “sectoral policies” by “sectoral”, as otherwise it seems to be at odds with the first line of the executive summary where “cross-sectoral” is mentioned. And in fact the main barrier to transformative climate action is precisely the fact that present policies do not take advantage of cross-sectoral synergies. [L. David Tabara, Spain]</td>
<td>Accept. Cross-sectoral is added to the text.</td>
</tr>
<tr>
<td>1114</td>
<td>7</td>
<td>30</td>
<td></td>
<td></td>
<td>The last sentence of this paragraph is important and may deserve more elaboration to avoid a framing of the summary that governments have the main role in meeting low-emissions targets. [Rob Swart, Netherlands]</td>
<td>Accept. Referred to the start of the paragraph and further elaborated.</td>
</tr>
<tr>
<td>7882</td>
<td>7</td>
<td>32</td>
<td></td>
<td></td>
<td>be clearly, including co-creative and tailored strategies for implementable and enforceable mechanisms that forge international agreements and targets. (4.4.1, 4.4.3) Non-state actors, including industry, civil society and scientific institutes play a key role in the governance mechanisms, a role that should be recognized in the conception of those mechanisms to increase ownership of and engagement with their implementation and enforcement post-facto. [Yana PIPKOSTOVA, France]</td>
<td>Accept. Noted. A modified version of this paragraph is the second paragraph of the ES in the SOD.</td>
</tr>
<tr>
<td>5445</td>
<td>7</td>
<td>32</td>
<td></td>
<td></td>
<td>It is suggested to substitute “numerous” by “some”, given the small number of such examples compared to the huge task ahead of us. [Pilar Rasell-Rodrigo, Spain]</td>
<td>Accept. Text change to “instances”</td>
</tr>
<tr>
<td>19252</td>
<td>7</td>
<td>32</td>
<td></td>
<td></td>
<td>isn’t “numerous”, slightly wrong” [Charlotte Volkle, France]</td>
<td>Noted. Text change to “instances”</td>
</tr>
<tr>
<td>14068</td>
<td>7</td>
<td>32</td>
<td></td>
<td></td>
<td>Examples of “societies” Or does it refer to institutional arrangements (see 36)? [Elvira Potschanka, Germany]</td>
<td>Noted. It refers more to “communities”. This was not modified in the text because countries are less like communities than societies.</td>
</tr>
<tr>
<td>7975</td>
<td>7</td>
<td>32</td>
<td></td>
<td></td>
<td>I am wondering how current examples can illustrate that achieving 1.5 degrees is possible. I have the feeling very bold assumptions regarding upscaling need to be made here. [Andreas Hof, Netherlands]</td>
<td>Taken into account. The text does not state that examples demonstrate that 1.5 is achievable, just that 1.5C compatible societies are possible. We have however nuanced the text in the SOD around this statement to make it less 1.5C-specific.</td>
</tr>
<tr>
<td>5734</td>
<td>7</td>
<td>32</td>
<td></td>
<td></td>
<td>The statement is true and the meaning is not very clear. [Hery Yang, Switzerland]</td>
<td>Taken into account. The statement is revised to make it clearer.</td>
</tr>
<tr>
<td>10607</td>
<td>7</td>
<td>42</td>
<td></td>
<td></td>
<td>This is the most important paragraph and should actually be fine in the summary, instead of the political correct but irrelevant first paragraph of page 6 summary. [Beau Brunier, Switzerland]</td>
<td>Taken into account. A modified version of this paragraph is the second paragraph of the ES in the SOD.</td>
</tr>
<tr>
<td>544</td>
<td>7</td>
<td>33</td>
<td></td>
<td></td>
<td>All the same line, very few cities, countries, businesses or communities are truly in line with 1.5C. This is not true. Over 35 cities in North America alone have committed to 100% clean, renewable energy (<a href="http://www.siemensclub.org/ready-for-100/cities-ready-for-100">http://www.siemensclub.org/ready-for-100/cities-ready-for-100</a>) as have over 100 major businesses worldwide (www100.org) and numerous communities (wwwlocal100.org). [Mark Jacobson, United States of America]</td>
<td>Taken into account. Reference is not peer-reviewed and there is no basis for such a statement in the chapter.</td>
</tr>
<tr>
<td>3734</td>
<td>7</td>
<td>33</td>
<td></td>
<td></td>
<td>The statement is about what is currently happening, not what cities aspire to deliver. [Andries Hof, Netherlands]</td>
<td>Taken into account. The text is removed to make it clearer.</td>
</tr>
<tr>
<td>2738</td>
<td>7</td>
<td>34</td>
<td></td>
<td></td>
<td>Not sure why cities are singled out here – what about rural areas? Regions? Rural-urban (urban) etc [Penny Urquhart, South Africa]</td>
<td>Noted - Text amended to include regions (which cover rural areas).</td>
</tr>
<tr>
<td>3095</td>
<td>7</td>
<td>34</td>
<td></td>
<td></td>
<td>Does not make sense for any entity smaller than the global community to be “fully in line” with 1.5°C or any other temperature goal. Temperature increase is a function of global cumulative emissions (at least approximately). Whether smaller entities are doing their ‘fair share’ depends on allocation and targets. [4.4.1; 4.4.3] Non-state actors, including industry, civil society and scientific institutes play a key role in the governance mechanisms, a role that should be recognized in the conception of those mechanisms to increase ownership of and engagement with their implementation and enforcement post-facto. [Yana PIPKOSTOVA, France]</td>
<td>Taken into account. The bottom-up processes and multi-level governance are emerging as mechanisms to strengthen the global response to both adaptation &amp; mitigation. It is not about “fair shares” necessarily, but more about individual examples that can serve as role models, taking into account different contexts.</td>
</tr>
<tr>
<td>16306</td>
<td>7</td>
<td>34</td>
<td></td>
<td></td>
<td>I would urge changing “increased ambition” to “Greatly increased ambition” to reflect more accurately how much greater ambition is really needed—-virtually all nations and ideas of the world are not even close to doing enough. [Michael MacCracken, United States of America]</td>
<td>Taken into account. Using words like “greatly” can be perceived as prescriptive. The difference between “increased” and “greatly increased” ambitions is not clear.</td>
</tr>
<tr>
<td>4464</td>
<td>7</td>
<td>37</td>
<td></td>
<td></td>
<td>The following wording is suggested: .., and collaborative networks in all regions including all main actors and decision makers. [Klaas Rasum, Australia]</td>
<td>Taken into account. The specific lead suggestion is not adopted, but “alignment of government and business institutions” is added. The point about mobile actors is made elsewhere (in the para on governance). See also response to comment 5446.</td>
</tr>
<tr>
<td>14992</td>
<td>7</td>
<td>40</td>
<td></td>
<td></td>
<td>Practically everywhere around the world, particularly in developing countries. – this appears to be an overstatement. [Farhan Akhtar, United States of America]</td>
<td>Accept. There is evidence that all around the world, also in developed countries, capabilities are a limiting factor. In an updated formulation, we further elaborate on this.</td>
</tr>
</tbody>
</table>
Challenges related to multinational networks do not only relate to scaling up but also to public representation and legitimacy of such networks (that is, what and whom they represent). This comment applies also to the relative sections mentioned in these lines. [J. David Tabara, Spain]

Noted, but at this point the chapter does not make this point. In our understanding, literature on this is lacking.

I would urge changing "short" to "far short" [Michael MacCracken, United States of America] Reject. See response to comment 16393.

I agree that changing lifestyle and behaviour is important, but I am not sure it will be necessary. Is this based on hard evidence? [Andries Hof, Australia]

Changing behaviour and lifestyle of whom? Of the Western industrialised countries or the developing ones or both? Special in the latter lifestyles are changing fast but in more carbon-intensive pathways. The report tends to use a language in which "people" and "individuals" readily seem to refer to the first kind of societies, hence ignoring cultural and socio-economic differences. [J. David Tabara, Spain] Noted. Behaviour changes are needed across the world, regarding both mitigation and adaptation.

This message (as the underlying text) rightly emphasizes changing behaviour in addition to the referendums to technological governance changes above, but by coupling this to lifestyles leaves assumed that the required transitions also have elements related to process changes (e.g. in industries) and maybe fundamental changes in economic and financial systems. [Rob Swart, Netherlands] Taken into account. It is mentioned on page 7, line 27 in the ES FOD, and page 6 in the SOD.

May be education could also be referred to in the Executive Summary [Charlotte Vallier, France] Taken into account. This paragraph has been completely rewritten and split to new paragraphs. Though still using the word "countries", ample attention is given to other governmental and non-governmental actions.

This message (as the underlying text) rightly emphasizes changing behaviour in addition to the referendums to technological governance changes above, but by coupling this to lifestyles leaves assumed that the required transitions also have elements related to process changes (e.g. in industries) and maybe fundamental changes in economic and financial systems. [Rob Swart, Netherlands]

Noted. The role of population growth particularly when combined with affluence is discussed in 4.3.5 which is mentioned in the ES. We aim for this in a part of the discussion in the context of "social feasibility" with the different mitigation options.

It seems to me neither one-sided to only highlight the positive opportunities here. It is clearly the case also that a very significant part of the political problem is in resistance to such behaviour change, or the "Widening" of existing practices. There is a very large literature on this. This should be acknowledged as a distinct political problem that needs attention. [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)] Taken into account (partially). Acceptability is discussed in 4.4.3. Resistance to change is not discussed explicitly in the ES. It is a part of the discussion in the context of "social feasibility" with the different mitigation options.

It is a concern that the public must be activated to enable our politicians to take the necessary steps to meet the challenges of climate change. Museums are uniquely qualified to contribute to activating the public on climate change awareness, mitigation, and resilience, because, in the words of Robert Janes, they have several exceptional characteristics. They are grounded in their communities and are expressions of locality. They are a bridge between science and culture; They bear witness by assembling evidence based on knowledge and making things known. They are used banks of sustainable living practices that have guided our species for millennia; They are some of the most free and creative work environments in the world. They enjoy an unprecedented degree of public trust; They are skilled at making learning accessible, engaging and fun. Finally they offer an existing global infrastructure - agents or avenues for local communities to utilise in accommodating local climate changes while also offering the IPCC an existing infrastructure to communicate the global challenges. [Maren Rees, Norway] Noted. It would however go too far to highlight this in the ES of this chapter. Also, literature is lacking on how museums could play a role. We do mention "greater public awareness and improved education" which is an area where museums could play a role.

A concern exists that the public must be activated to enable our politicians to take the necessary steps to meet the challenges of climate change. Museums are uniquely qualified to contribute to activating the public on climate change awareness, mitigation, and resilience, because, in the words of Robert Janes, they have several exceptional characteristics. They are grounded in their communities and are expressions of locality. They are a bridge between science and culture; They bear witness by assembling evidence based on knowledge and making things known. They are used banks of sustainable living practices that have guided our species for millennia; They are some of the most free and creative work environments in the world. They enjoy an unprecedented degree of public trust; They are skilled at making learning accessible, engaging and fun. Finally they offer an existing global infrastructure - agents or avenues for local communities to utilise in accommodating local climate changes while also offering the IPCC an existing infrastructure to communicate the global challenges. [Maren Rees, Norway] Noted. Again the role of museums is missing on how museums could play a role. We do mention "greater public awareness and improved education" which is an area where museums could play a role.

It is suggested to screen rhetoric on successful examples how barriers could be overcome in order to change lifestyle and behaviour. It seems very important to use the power of young people (age of 10 to 14) to educate their parents and grandparents. Unfortunately, Article 8 of the Convention has not been a strong focus and now. See also the suggestions in the book "The Ostrich Paradox". Why the Underpapare for Disaster. By Robert Meyer and Howard Kunreuther. [Klaus Radunsky, Austria] Noted. This was not added since it is too specific to be added at the ES. Also, the evidence base for this is not strong.

We think the concept of circular economy could be mentioned here (4.4.3). [Kyril Christophersen, Norway] Taken into account. Chapter 5 addresses it in the context of the SODs. Chapter 4 only to the context of deep emission reductions in industry (4.3.5) which is mentioned only cursory in this ES. We aim for the ES to remain succinct and have a narrative that goes beyond a list of mitigation options for deep emission reductions and their possibilities and limitations. Hence the limited emphasis on the concept here.

Education can reduce fertility rates - but higher education generally promotes materialized happiness, increasing extraction, consumption and emission rates. [Brigit van Munster, United Kingdom (of Great Britain and Northern Ireland) Noted. The role of population growth particularly when combined with affluence is discussed in 4.4.3. The link between higher education and materialised happiness has limited supportive evidence globally.

Education and media can de-materialize wellbeing: after basic needs, happiness is people and activities - social nonmaterial actions - not endlessly working-saving-spending-buying-products resulting in destructive extracting of limited natural resources and dangerous emissions. [Brigit van Munster, United Kingdom (of Great Britain and Northern Ireland)] Noted. See response to comment 19339.

Re behaviour and lifestyle change: Education and media are (the) principal agents of behaviour change. Nearly 100% of media - including social media - is commercial, promoting "materialised happiness" / purchases and consumption of products, and thereby extraction of rapidly depleted natural resources and production of climate changing emissions. [Brigit van Munster, United Kingdom (of Great Britain and Northern Ireland)] Noted. Information and education, though important and mentioned elsewhere in the ES, is not always effective in changing behaviour; it also not the only agents for behavioural change. This is further discussed in 4.4.3. We also indicate that wellbeing is not based on Hedonism but also materialism in this section. It goes too far to indicate that present in the ES.

Changing behaviour and lifestyles suggests over-consumption is the key issue here, treating the lifestyles of the affluent, industrialised world as a global norm. I am not sure this is what is intended. After all, we should be supporting the aspirations of those in poverty to live more prosperous lifestyles but doing so in a way that capitalises on opportunities to decrease production, regenerate ecosystem processes etc. "Changing behaviour and lifestyles" also suggests (1) that it is individual behaviour, attitudes and values that are the problem, not the social and economic structures in which they are embedded; and (2) that the social and behavioural factors that influence lifestyles and consumption are more or less equivalent regardless of the resources being consumed (i.e. food, water, energy, housing etc.). I would like to see this paragraph re-framed around enabling "behaviours and lifestyles that enable sustainability transitions; that is, transitions to more equitable and more environmentally sustainable ways of life. [Stewart Lockie, Australia] Taken into account. Behaviour change requires enabling environments, see section 4.4.3 (in the SOD) and strengthening motivation change. We refer to wasteful consumption in the SOD ES, but it is not put over consumption and putting the emphasis only on individuals. We invite the text to emphasise the crucial virtuous cycle of: behavioural change, political support for more change, and more behavioural change etc.

Do Not Quote, Cite, or Distribute Page 23 of 159
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>13916</td>
<td>7</td>
<td>46</td>
<td>7</td>
<td>49</td>
</tr>
<tr>
<td>14064</td>
<td>7</td>
<td>45</td>
<td>7</td>
<td>47</td>
</tr>
<tr>
<td>7881</td>
<td>7</td>
<td>49</td>
<td>7</td>
<td>51</td>
</tr>
<tr>
<td>14067</td>
<td>7</td>
<td>45</td>
<td>7</td>
<td>46</td>
</tr>
<tr>
<td>7882</td>
<td>7</td>
<td>48</td>
<td>7</td>
<td>49</td>
</tr>
<tr>
<td>14069</td>
<td>7</td>
<td>45</td>
<td>7</td>
<td>47</td>
</tr>
<tr>
<td>7883</td>
<td>7</td>
<td>40</td>
<td>7</td>
<td>50</td>
</tr>
<tr>
<td>14094</td>
<td>7</td>
<td>51</td>
<td>7</td>
<td>55</td>
</tr>
<tr>
<td>2739</td>
<td>7</td>
<td>51</td>
<td>7</td>
<td>55</td>
</tr>
<tr>
<td>7894</td>
<td>7</td>
<td>51</td>
<td>7</td>
<td>55</td>
</tr>
<tr>
<td>3658</td>
<td>7</td>
<td>50</td>
<td>7</td>
<td>51</td>
</tr>
<tr>
<td>14095</td>
<td>7</td>
<td>52</td>
<td>7</td>
<td>53</td>
</tr>
</tbody>
</table>

### Comment

Include references / mention of the developments of a global Circular Economy and transition from a Linear to a Circular system e.g. regarding behavior and lifestyles. (source adapted from Siemens, Klaus Lützenkirchen - Head of Corporate Environmental Protection Munich Germany)

- The present dominant Linear Economy model has strong implications to the degree of Climate Changes on Earth. Earth is a closed system where matter and emissions remain in the system and the Earth functions in natural cycles with natural limits to resources. Societies need to consider these limits in order to survive. A Circular Economy model keeps products, components and materials at their highest utility and value at all times. A Circular Economy is restorative and regenerative by design and distinguishes between biological cycles and technical cycles.
- Sustainable Economy industrial model thinking respects the cyclical nature of the Earth where products are designed and manufactured in a way that does not exceed the natural limits of resources and ecosystems. Harmful substances or emissions are phased out of manufacturing processes or prevented from entering socio-systems and purify or are recycled at the same rate as resources are being consumed. Worldwide population growth is spurring increased demands in consumable goods and is causing increased residual waste streams arising from the take, make, waste Linear Economy model. A Circular Economy system of thinking is focused on eliminating potential unsustainable waste streams, including greenhouse gas emissions.

- Examples of resource efficiency being addressed around the world include the United Nations 2030 Agenda for Sustainable Development with responsible consumption and production targets; the German GER Resource Efficiency Program; the Chinese CH Resource and Environment Index; and the United States US Sustainable Material Management Program. In addition, many multinational companies are beginning to source 100% of their product related materials from recycled goods (Nike, Apple). In this context a Circular Economy model game tracion in policymaking to achieve economic development within environmental constraints.


- Common characteristics of the Circular Economy are material loop closing; pollutant elimination; and increasing material efficiencies. Circular business models look at new relationships and are key to overcoming the limitations of linear approaches. Circular input models, waste value models, or profit models (Life Cycle Analysis), platform models, and products as services models are all examples of Circular Economy thinking which are disruptive and are powered by new technologies and in particular through digital connectivity via mobile devices and machine-to-machine [Geraldine Ann Cusack, Ireland].

- The issue of lifestyles and behavior change is important to include in the discussion of the Circular Economy because policy makers have the ability to influence behavior that is detrimental to the environment. Policy instruments, both price and non-price, can be used to accelerate the deployment of carbon-neutral technologies ahead of their prospectively achieved cost-effectiveness. This could lead to misunderstandings and misgivings. (Jennifer Morgan, United States US Sustainable Material Management Program. In addition, many multinational companies are beginning to source 100% of their product related materials from recycled goods (Nike, Apple). In this context a Circular Economy model game tracion in policymaking to achieve economic development within environmental constraints.

- The last part of this comment is not clear.

- The last part of this comment is not clear.

- Circular business models are key to overcoming the limitations of linear approaches. Circular input models, waste value models, or profit models (Life Cycle Analysis), platform models, and products as services models are all examples of Circular Economy thinking which are disruptive and are powered by new technologies and in particular through digital connectivity via mobile devices and machine-to-machine [Geraldine Ann Cusack, Ireland].

- The issue of lifestyles and behavior change is important to include in the discussion of the Circular Economy because policy makers have the ability to influence behavior that is detrimental to the environment. Policy instruments, both price and non-price, can be used to accelerate the deployment of carbon-neutral technologies ahead of their prospectively achieved cost-effectiveness. This could lead to misunderstandings and misgivings. (Jennifer Morgan, United States US Sustainable Material Management Program. In addition, many multinational companies are beginning to source 100% of their product related materials from recycled goods (Nike, Apple). In this context a Circular Economy model game tracion in policymaking to achieve economic development within environmental constraints.

- The last part of this comment is not clear.

- The last part of this comment is not clear.

- The last part of this comment is not clear.
18702 7 53 7 55
the formulation “before they can be more cost-effective than fossil fuels implies that the cost would be the single-determining factor whether the
theories (and even the “level playing field”) matter. However, the cost must also be considered that the main purpose of such policies and measures has been to have the rapid-enough dissemination of carbon neutral technologies (where cost-effectiveness is one
of course, important factor, but there are also additional important barriers that impede the dissemination, e.g. political economy aspects etc.). It could further
note from a macro-economic perspective, taking into account e.g. avoided adverse climate impacts, but also direct sustainable benefits of carbon
neutral technologies (such as in the area of health) need to be taken into account in a perspective of “cost-effectiveness” [Evan Harrington, Germany]

1797 8
There are clear contradictions throughout the document between “non-state actors playing a key role”, “bottom-up initiatives” and the necessary “fast track active intervention” and “serious community engagement for efficient and clear actions” of states and international organisations. No clear answer to the
question is given in the document of how the bottom-up and top-down decisions can meet for taking efficient short term decisions (also taking into
account the internal and external political uncertainties). [Jean Marie Soker, France]

10510 8
No words about a tax on carbon ? A carbon tax, which proceeds are used to finance renewables is a very powerful tool. [Beat Brunner, Switzerland]

10503 8 3 8 3
AIS sentence “market mechanisms for mitigation play an important role in reducing mitigation cost, thus leading to higher ambition and an increased
likelihood to reach the 1.5°C target of the Paris Agreement (4.4.7) [Axel Michaelowa, Switzerland] Taken into account. We have included a more specific sentence on “carbon pricing is a necessary but insufficient part of the (policy mix)”.

10508 8 4 8 4
4.5. “1.5°C-compatible worlds” should be angular, we have a single Planed Earth and it is not understandable like it is now. Suggesting: “To be able to limit warming to 1.5°C” [Beat Brunner, Switzerland]
Reject. We have multiple possible outcomes of a 1.5°C warmer world. This is the only comment on the understandability.

14955 8 4 8 9
Include private sector here more explicitly as well, not just public financial institutions, e.g. “including central and multilateral banks, financial institutions, and other investors” [Faranth Akhtar, United States of America]

19710 8 4 8 9
The review of ESG and climate justice can help to drive climate compatible investment. Pursuing Climate Justice within Environmental, Social and
Investment-Frameworks-Mary-Robinson-Foundation-Climate-Justice-Jan-2017.pdf] [Tara Shine, Ireland]

1111 8 5 8 6
The financial sector (here and in the following texts) gets relatively little attention but seems of key importance. Here, at least other actors should be
included such as asset managers, pension funds and other institutional investors. [Rob Swart, Netherlands]

7899 8 4 8 6
1.5°C-compatible worlds will require active intervention to reduce risk investments in low-carbon technologies and to redefined world savings. This implies
the involvement of the financial sector including central banks, and the role of financial sector, including banks, and has an international finance basis.
There needs to be a more comprehensive discussion about domestic resource mobilization, and the role of cities in finance, including land value capture. [Westphal Michael, United States of America]

13691 8 6 8 11
Also development banks – at national and regional level [Harald Winkler, South Africa]

7895 8 8 8 10
Public guarantees, development assistance and support of non-state actors could facilitate enhanced adaptation investment and to a certain extent
accelerate the development from high to low-carbon assets which is already happening. [Hana POKROVSKA, France] Taken into account. Mitigation is mentioned in this sentence now, which has been significantly revised.

3961 8 8 8 16
... – systems can be blocked in a direction which promotes and sustains climate action. It is feasible to attempt identifying hierarchal priorities of Carbon
Reduction and governance which can applied and adapted in policy making, in national and cross-national synergies and coalitions need to be recognized and empowered because the pathway to 1.5°C cannot be effective without the university engagement with and
ownership of the process [Hana POKROVSKA, France]

7200 8 15 8 8
Gaps in knowledge on the effect disruptive emerging technologies on the energy use and CO2 emissions need to be resolved. They include questions how
disruptive technologies, such as additive manufacturing, robotics, drones and the Internet of Things increase or decrease energy consumption and
if policies can be developed to maximise the beneficial effects of these technologies and the cost-effectiveness of interventions concerning these technologies. (4.3.2.4, 4.4.6) [Leendert Verhoef, Netherlands]

16578 9 1 10 32
A new and innovative chapter [Peter Neubauer, Switzerland] Accepted. We have included a more specific sentence on “carbon pricing is a necessary
but insufficient part of the (policy mix)”.

2229 9 1 10 33
Suggest to delete. The section only summarises key messages from AR5 and the parts on 1.5°C are not substantiated by references. [Kenneth Middelberg, Sweden]
Rejected - we don’t find this sentence.

1308 8 1 10 33
4.1. star with the narrative arc (plotline) of the chapter and introduce the various sections of the remaining chapter at the end. [Petra Taskach, Austria]
Accepted - we have included this section to include accordingly.

19711 9 1 9 2
Note that the opportunities posed by the transition to a 1.5 world includes opportunities for justice, rights and gender equality if climate actions are
designed with human rights and gender equally in mind. Without integration of these issues as indicated in the Preparatory of the Paris Agreement the
challenges associated with 1.5 pathways will be greater, as will the risks. [Tara Shine, Ireland]

14095 9 14 8 12
practical principles of climate resilient governance is ill-defined. Suggest the authors refrain from referring to principles that are not well established
and commonly agreed. [Faranth Akhtar, United States of America]
Accept. Revised to make it conditional.

7896 8 15 8 16
... – systems can be blocked in a direction which promotes and sustains climate action. It is feasible to attempt identifying hierarchal priorities of Carbon
Reduction and governance which can applied and adapted in policy making, in national and cross-national synergies and coalitions need to be recognized and empowered because the pathway to 1.5°C cannot be effective without the university engagement with and
ownership of the process [Hana POKROVSKA, France]

2320 9 5 9 5
There needs to be a qualification here–not all types of serious impacts “can be alleviated by adaptation and development responses”, including the
committed to sea level rise that is being initiated and the loss of biodiversity that is occurring due to climate and ocean acidification--at least they cannot
be meaningfully alleviated. [Michael MacCracken, United States of America]
Accepted - text has been modified.

2740 9 8 8 10
Suggest adding “and their co-benefits” after “adaptation and mitigation responses” [Pamela Unuput, South Africa]
Accepted - Have amended text to take this into account.

4099 9 8 8 10
It is not clear whether adaptation and mitigation responses have been discussed together. Why it is not separately as in previous AR7. Why is it that a
discussion on mitigation has to deal with issues such as equity and justice? …very important for society but rather out of scope of a discussion on how to
achieve the 1.5°C target … [Alexandra Carls, Sweden]
Accepted - Have added text on behavioural change in checklist of preconditions.

1118 9 10
Isn’t this the focus of chapter 5?? [Rob Swart, Netherlands]

2084 8 1 9 22
Need to add the importance of institutional/personal responsibility, the same goes for entire section [Lia Lucas, United States of America]
Accepted - Have added text on behavioral change in checklist of preconditions.
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>13050</td>
<td>9</td>
<td>14</td>
<td>9</td>
<td>14</td>
<td>I am not clear what &quot;social cost&quot; means - if it considers only economic costs (few lines before it is written &quot;maximizing economic efficiency&quot;) (Casiem [Steffen, Yes])</td>
<td>Rejected - we are forced to refer to the glossary and the box on economics on 1.5 because of the space restrictions.</td>
</tr>
<tr>
<td>16396</td>
<td>9</td>
<td>17</td>
<td>9</td>
<td>19</td>
<td>I am not clear what is meant here. With recent technology advances it is becoming less expensive to be deriving energy from renewable resources. What needs to be overcome is the inertia created by large business interests. I just do not think &quot;mediating&quot; is the right word here, in addition to it not being very clear as to meaning. (Michael MacCracken, United States of America)</td>
<td>Accepted - changed to &quot;managing the economic impact&quot; with the assumption that impact can be positive.</td>
</tr>
<tr>
<td>16397</td>
<td>9</td>
<td>19</td>
<td>9</td>
<td>22</td>
<td>Does this statement not assume that the least-cost development path in the future will be fossil-fuel derived energy with its necessary energy investments and harmful emissions to health, air quality, water quality, and more? With renewable energy costs declining rapidly (and much greater improvements) in the pipeline, including that will avoid the need for petroleum powered individual transportation. It is seem that the cost of development with distributed renewables is going to be less than the costs and indirect impacts from fossil fuel. If this is the case, then the pressure to cut fossil fuel emissions to zero has actually stimulated technology development that will make development less expensive than it has been. (Michael MacCracken, United States of America)</td>
<td>Rejected in this section because we simply sum up the AR5 conclusions that state that there is always a marginal cost, that the deployment of low-carbon energy systems implies higher energy costs, even in the most optimistic assumptions. The rest of the chapter will discuss how to overcome this difficulty.</td>
</tr>
<tr>
<td>2230</td>
<td>9</td>
<td>24</td>
<td>9</td>
<td>24</td>
<td>All these claims need references. (Kenneth Millersten, Sweden)</td>
<td>Rejected - we simply note that what has to be accelerated to reach 1.5. Accelerated change requires additional sets of efforts and policies.</td>
</tr>
<tr>
<td>6725</td>
<td>9</td>
<td>25</td>
<td>9</td>
<td>27</td>
<td>Despite acknowledging the power of behaviour and systemic political and economic changes in improving resilience and reducing emissions, the report is quick to signal that the only way we could reach 1.5°C is with “highly invasive and expensive coal-based removal technologies.” Opening the door to be more systemic political and social changes as needed to reach 1.5° they should be assessed at least at the same level of detail as carbon removal technologies. Rather than yielding quickly to report what is known or writing the areas of comfort of the IPCC. (Jannett Morgen, Netherlands)</td>
<td>Taken into account - Thank you for pointing out your difficulty</td>
</tr>
<tr>
<td>4300</td>
<td>9</td>
<td>26</td>
<td>9</td>
<td>33</td>
<td>The rhetoric of section 4.1 is overwhelming. Example: “I have read 5 times the last paragraph of the section, and still do not know what is the message other than the obvious need of a coherent governance...” May be it is just my problem. (Ana Raquel Carlos, Spain)</td>
<td>Taken into account - Thank you for pointing out your difficulty</td>
</tr>
<tr>
<td>2231</td>
<td>9</td>
<td>27</td>
<td>9</td>
<td>29</td>
<td>The second significant difference is that a 1.5°C transition requires structural changes from the global to local level in development pathways and governance, and in economic, financial, institutional, social and technical systems. This needs to be substantiated with references to adequate reports and articles. (Kenneth Millersten, Sweden)</td>
<td>Accepted and amended.</td>
</tr>
<tr>
<td>11141</td>
<td>9</td>
<td>28</td>
<td>9</td>
<td>29</td>
<td>The second significant difference is that a 1.5°C transition requires structural changes from the global to local level in development pathways and governance, and in economic, financial, institutional, social and technical systems. - This is a blanket statement without link to re-reading the report or references. (Michał Schwerfer, Poland)</td>
<td>Accepted and amended.</td>
</tr>
<tr>
<td>2485</td>
<td>9</td>
<td>29</td>
<td>9</td>
<td>29</td>
<td>Should the importance of land management be mentioned here? The lower the temperature target, the greater the importance of land-based solutions. (Rob Swart, Netherlands)</td>
<td>Rejected in this section because we simply sum up the AR5 conclusions that state that there is always a marginal cost, that the deployment of low-carbon energy systems implies higher energy costs, even in the most optimistic assumptions. The rest of the chapter will discuss how to overcome this difficulty.</td>
</tr>
<tr>
<td>30697</td>
<td>9</td>
<td>30</td>
<td>9</td>
<td>32</td>
<td>Is it not clear the “social cost” means, if it considers only economic costs (few lines before it is written “maximizing economic efficiency”) (Casiem [Steffen, Yes])</td>
<td>Rejected - we are forced to refer to the glossary and the box on economics on 1.5 because of the space restrictions.</td>
</tr>
<tr>
<td>30699</td>
<td>9</td>
<td>31</td>
<td>9</td>
<td>33</td>
<td>Instead of focusing on “no regrets” and “negative cost” options, which some will dispute, especially the latter, can you instead say the same thing but focus on the mitigation co-benefits of alternative development and adaptation actions? E.g. the benefits of transit oriented city development. (Christopher Bataille, Canada)</td>
<td>Accepted and furthered more positively.</td>
</tr>
<tr>
<td>18972</td>
<td>9</td>
<td>31</td>
<td>9</td>
<td>33</td>
<td>Need to add a reference to the Paris Agreement’s commitments to respect human rights and gender equality in climate action (see the preamble to the Paris Agreement) (Tara Shine, Ireland)</td>
<td>Rejected - we are forced to refer to the glossary and the box on economics on 1.5 because of the space restrictions.</td>
</tr>
<tr>
<td>17679</td>
<td>9</td>
<td>31</td>
<td>9</td>
<td>39</td>
<td>The chapter is right to draw attention to these 6 objectives. It is also important to add that the global response should be in line with principles of equity - each country and common but differentiated responsibilities and respective capacities. This is also in line with later statements in the chapter [page 12, line 28] (Simon Caney, United Kingdom (of Great Britain and Northern Ireland))</td>
<td>Accepted - and rephrased.</td>
</tr>
<tr>
<td>19319</td>
<td>9</td>
<td>31</td>
<td>9</td>
<td>39</td>
<td>Crucial paragraph, to be phrased as precisely as possible. There is room for improvement. (Marco Mazzotti, Switzerland)</td>
<td>Accepted and rephrased.</td>
</tr>
<tr>
<td>10215</td>
<td>9</td>
<td>31</td>
<td>9</td>
<td>39</td>
<td>Has the intro but this paragraph seems too much uninterested author opinion - Where do these 6 things come from? (Tara Shine, Ireland)</td>
<td>Taken into account - We have addressed this with cross references to Chapters 5 on new trends required and &quot;enabling environment&quot; in Chapter 4. On re-reading this section we have now rewritten point 4.</td>
</tr>
<tr>
<td>16388</td>
<td>9</td>
<td>31</td>
<td>9</td>
<td>39</td>
<td>It seems to me that this conclusion needs to more clearly emphasize the need for ongoing research and development, including facilitating new technologies that seem to get stuck in the transition from research accomplishment to being marketed. The first point talks about facilitating &quot;options&quot; but a number of the emerging technological advances have yet to be recognized as options in any of the analyses done by integrated assessment models (e.g. ocean turbines that actually work by going to magnetic bearings instead of ball bearings; fast charge batteries that are possible by focusing on use of ultra-capacitors instead of chemical, rare element batteries; etc.) [COI note- I'm personally trying to encourage both, including by minor investment in the former] (Michał MacCracken, United States of America)</td>
<td>Rejected - We have referenced new technologies and innovation, but cannot go into this level of detail in an introductory section.</td>
</tr>
</tbody>
</table>
The author forgot to mention "actual action" in deep decarbonization. It’s fine to have an enabling environment but if economic agents do not take the opportunity to act, nothing happens and the goal goes out of reach.

Since the Paris Agreement is the frame of the paragraph, it’s important to report all its main keywords (mitigation and adaptation but also resilience and “loss and damage”) to which one sentence has been agreed and should not be re-ignored.

The meaning of "no-regret" is from the old age where there were uncertainties about the existence of climate change or whether it is a hoax, thus only non-regrets actions, defensible even in absence of climate change, were prominently supported. Since 2007, anthropogenic climate change is "unequivocal" and its large scale damage do justify even high costs of mitigation action. Note that costs to polluters do not count in this, because of the "polluters pay principle."

Accordingly, the text should be integrated in a way like this: "In the context of the Paris Agreement, the global response therefore implies the need to focus on: (1) accelerating the realization of "no-regret" and "negative costs" options to deliver short-term development, mitigation and adaptation co-benefits (including deforestation and land degradation); (2) improving access to finance; (3) strengthening cross-country and cross-sectoral policy packages, by leveraging all avenues and tools indicated by the Agreement; (4) accelerating the implementation of policy packages apt to deliver mitigation and adaptation co-benefit of long-term development benefits and universal improvements in quality of life, including response measures for countries and sectors particularly hit by mitigation actions, and in more general terms Sustainable Development Goals; (5) enabling environments that help address institutional, market and behavioural barriers to these perspectives; (6) actual action in deep decarbonization; (7) increasing the profitability of production of (and investment in) clean technologies and behaviours; (8) diverting investments from past and current trends that can lead to a lock-in into climate-vulnerable and carbon-intensive development pathways; (9) reinforcing innovation processes, changes in lifestyles and spatial dynamics that will allow for further deep reductions in GHG emissions; (10) enhancing the adaptive capacity of key systems at risk (e.g., water, energy, food, cities and coastal resources) to climate change impacts; (11) anticipating, minimizing and managing risks arising from actual climate change losses and damages; (12) increasing resilience and capability of recovery from losses and damages, also thanks to international and domesic solidarity networks. \[Valentino Piana, Italy\]

How authors find that Paris Agreement is indicating diverting investments from current trends, that can lead to a kick into climate-vulnerable and carbon-intensive development pathways. Are we considering 17 SDGs or only energy and climate related ones? \[Zoha Shawoo, United Kingdom (of Great Britain and Northern Ireland)\]

There are two rather different statements here both about the political feasibility question. It is not clear if they are intended to be linked and similar points. If so, it is mistaken, they refer to rather different political points. In the former, it is popular backlash against climate policy because of unemployment which is the risk, in the latter it is the power of large companies - those holding fossil fuel assets and their investors - who could jamp the risk. Minimising the risk of the former is intrinsic to the challenge of 1.5C in that popular backlash can derail the political process. But I do not see how it is possible to achieve 1.5C without hurting the assets of those holding extensive FF assets. Minimising the losses to those interests stands in a direct contradiction to 1.5C. The political challenge is thus to create sufficient political support to overcome the opposition of those interests and/or to directly compensate them for their losses. \[Jennifer Morgan, United Kingdom (of Great Britain and Northern Ireland)\]

Surely protecting carbon-intensive assets is incompatible with climate action? \[Zoila Shawoo, United Kingdom (of Great Britain and Northern Ireland)\]

Mitigation and adaptation but also resilience and “loss and damage” to which one sentence has been agreed and should not be re-ignored.

That the transition to a green energy system will result in more jobs, greater efficiency, greater energy security, reduced environmental pollution and health problems, and more needs to be emphasized. Yes, fossil fuel infrastructure investment may be lost, but for most people the benefits will far exceed the loss of economic value of fossil fuel infrastructure, particularly if developing nations avoid taking the same fossil fuel path as developed nations—and this is technologically possible without sacrificing energy services if done thoughtfully. \[Michael Kite/Crackin, United States of America\]

It may be hard to accelerate climate action if the loss of economic value of carbon-intensive assets, which appears unavoidable, cannot be minimized. Combined with the report’s extensive discussion of carbon removal technologies, there appears to be a bias. Carbon removal technologies have a central role in the report whereas loss of economic value of carbon-intensive assets does not. In other words, there seems to be an implicit preference to undergo risks associated with unproven and expensive carbon removal technologies rather than exploring the possibilities of a managed decline of a carbon economy like the loss of economic value of carbon-intensive assets now. \[Jennifer Morgan, Netherlands\]

It may be hard to accelerate climate action if the loss of economic value of carbon-intensive assets, which appears unavoidable, cannot be minimized. Combined with the report’s extensive discussion of carbon removal technologies, there appears to be a bias. Carbon removal technologies have a central role in the report whereas loss of economic value of carbon-intensive assets does not. In other words, there seems to be an implicit preference to undergo risks associated with unproven and expensive carbon removal technologies rather than exploring the possibilities of a managed decline of a carbon economy like the loss of economic value of carbon-intensive assets now. \[Jennifer Morgan, Netherlands\]

It may be hard to accelerate climate action if the loss of economic value of carbon-intensive assets, which appears unavoidable, cannot be minimized. Combined with the report’s extensive discussion of carbon removal technologies, there appears to be a bias. Carbon removal technologies have a central role in the report whereas loss of economic value of carbon-intensive assets does not. In other words, there seems to be an implicit preference to undergo risks associated with unproven and expensive carbon removal technologies rather than exploring the possibilities of a managed decline of a carbon economy like the loss of economic value of carbon-intensive assets now. \[Jennifer Morgan, Netherlands\]

It may be hard to accelerate climate action if the loss of economic value of carbon-intensive assets, which appears unavoidable, cannot be minimized. Combined with the report’s extensive discussion of carbon removal technologies, there appears to be a bias. Carbon removal technologies have a central role in the report whereas loss of economic value of carbon-intensive assets does not. In other words, there seems to be an implicit preference to undergo risks associated with unproven and expensive carbon removal technologies rather than exploring the possibilities of a managed decline of a carbon economy like the loss of economic value of carbon-intensive assets now. \[Jennifer Morgan, Netherlands\]

It may be hard to accelerate climate action if the loss of economic value of carbon-intensive assets, which appears unavoidable, cannot be minimized. Combined with the report’s extensive discussion of carbon removal technologies, there appears to be a bias. Carbon removal technologies have a central role in the report whereas loss of economic value of carbon-intensive assets does not. In other words, there seems to be an implicit preference to undergo risks associated with unproven and expensive carbon removal technologies rather than exploring the possibilities of a managed decline of a carbon economy like the loss of economic value of carbon-intensive assets now. \[Jennifer Morgan, Netherlands\]

We should not care only about polluters being subsidised once more. We need to positively incentivise clean technologies providers and users. Accordingly, the sentence ending with "cannot be minimized" should be changed into "cannot be somehow compensated, provided this reduces vulnerabilities to change and actually leads to faster development. High profile should accrue to institutions, producers, investors and users of aeronautical and low-emission technologies in all sectors, so as to boost self-funded and externally-funded expansion at fast pace, leading to employment, exports, and tax revenues." \[Valentino Piana, Italy\]

We should not care only about polluters being subsidised once more. We need to positively incentivise clean technologies providers and users. Accordingly, the sentence ending with "cannot be minimized" should be changed into "cannot be somehow compensated, provided this reduces vulnerabilities to change and actually leads to faster development. High profile should accrue to institutions, producers, investors and users of aeronautical and low-emission technologies in all sectors, so as to boost self-funded and externally-funded expansion at fast pace, leading to employment, exports, and tax revenues." \[Valentino Piana, Italy\]

Can you be more descriptive when you discuss a "shift in the production frontier of the economy". Do you mean development reduction, adaptation reduction, mitigation reduction \[Wilfran Moufouma Okia, France\]

It may be hard to accelerate climate action if the loss of economic value of carbon-intensive assets, which appears unavoidable, cannot be minimized. Combined with the report’s extensive discussion of carbon removal technologies, there appears to be a bias. Carbon removal technologies have a central role in the report whereas loss of economic value of carbon-intensive assets does not. In other words, there seems to be an implicit preference to undergo risks associated with unproven and expensive carbon removal technologies rather than exploring the possibilities of a managed decline of a carbon economy like the loss of economic value of carbon-intensive assets now. \[Jennifer Morgan, Netherlands\]
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>9862</td>
<td>10</td>
<td>1</td>
<td>10</td>
<td>2</td>
<td>The authors have cited 2015 data but they may use the latest publication by the UN on World Population Statistics, refer to - United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects.</td>
<td>Taken into account - Noted thank you.</td>
</tr>
<tr>
<td>14119</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>2</td>
<td>Structure consistency with chapter 2 of this report chapter 2 (p. 21) across the document.</td>
<td>Taken into account</td>
</tr>
<tr>
<td>4634</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>The author should mention the SDGs, e.g. in the updated version; &quot;These trends are likely to continue for the next few decades&quot; (Butt et al. 2014), in interaction with the efforts and achievements in the Sustainable Development Goals, as well as...</td>
<td>Rejected - Good remark, but we think that it is inappropriate in this section</td>
</tr>
<tr>
<td>4837</td>
<td>10</td>
<td>5</td>
<td>10</td>
<td>6</td>
<td>Add to list of disruptive technologies: 3D-printing (sometimes called ‘additive manufacturing’). (Valentino Piana, Italy)</td>
<td>Taken into account - but too much detail for this introduction, so we have removed reference to nano and bio-technologies in favour of &quot;new technologies&quot;</td>
</tr>
<tr>
<td>19294</td>
<td>10</td>
<td>8</td>
<td>10</td>
<td>8</td>
<td>I am not sure the understanding of “Nevertheless...” [Charlotte Vailles, France]</td>
<td>Taken into account - we have changed the text.</td>
</tr>
<tr>
<td>2741</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>22</td>
<td>Climate policies are by definition and of necessity framework policies, requiring mainstreaming into all other sectors for their functioning. Therefore the area of potential could more accurately be termed a failure to achieve the necessary mainstreaming to date - even in countries where climate policy is relatively well-developed. [Penny Unruh, South Africa]</td>
<td>Accepted - we have added a reference to mainstreaming.</td>
</tr>
<tr>
<td>3983</td>
<td>10</td>
<td>21</td>
<td></td>
<td></td>
<td>suggest: it's aligning (and aligning) climate policy with other public policies (local, industrial, urban planning, infrastructure, innovation) [Barbara Norman, Australia]</td>
<td>Accepted - we have added a reference to mainstreaming.</td>
</tr>
<tr>
<td>17740</td>
<td>10</td>
<td>26</td>
<td>10</td>
<td>26</td>
<td>See reference to publication on the essence of global governance and an international governance structure for climate governance <a href="http://www.un.org/development/desa/policy/pak052004_mil052004_life052004_climate_global_governance.pdf">http://www.un.org/development/desa/policy/pak052004_mil052004_life052004_climate_global_governance.pdf</a></td>
<td>Taken into account - Paragraph has been substantially revised.</td>
</tr>
<tr>
<td>14070</td>
<td>10</td>
<td>26</td>
<td>10</td>
<td>33</td>
<td>Does the paragraph also need to mention the FCC ambition gap – see Exec Summary p9 or 8-9 [Dorota Ploszaka, Poland]</td>
<td>Accepted - we have added, and how co-operation can bridge the gap.</td>
</tr>
<tr>
<td>1705</td>
<td>10</td>
<td>26</td>
<td>10</td>
<td>34</td>
<td>While outlining climate policy implementation strategies (under heading Accelerating the global response to climate change) on page 9 of the document, it is essential to focus on &quot;global environmental governance&quot; (GEG). The GEG is the sum of organizations, policy instruments, financing mechanisms, rules, procedures and norms that regulate the processes of global environmental protection. The efficacy of global environmental governance will ultimately depend on implementation at global and domestic levels. [Mishra Santosh Kumar, India]</td>
<td>Accepted - we have refined accordingly</td>
</tr>
<tr>
<td>1715</td>
<td>10</td>
<td>26</td>
<td>10</td>
<td>34</td>
<td>While outlining climate policy implementation strategies (under heading Accelerating the global response to climate change) on page 9 of the document, it is essential to focus on &quot;global environmental governance&quot; (GEG). The GEG is the sum of organizations, policy instruments, financing mechanisms, rules, procedures and norms that regulate the processes of global environmental protection. The efficacy of global environmental governance will ultimately depend on implementation at global and domestic levels. [Mishra Santosh Kumar, India]</td>
<td>Accepted - we have refined accordingly</td>
</tr>
<tr>
<td>1720</td>
<td>10</td>
<td>26</td>
<td>10</td>
<td>34</td>
<td>While outlining climate policy implementation strategies (under heading Accelerating the global response to climate change) on page 9 of the document, it is essential to focus on &quot;global environmental governance&quot; (GEG). The GEG is the sum of organizations, policy instruments, financing mechanisms, rules, procedures and norms that regulate the processes of global environmental protection. The efficacy of global environmental governance will ultimately depend on implementation at global and domestic levels. [Mishra Santosh Kumar, India]</td>
<td>Accepted - we have refined accordingly</td>
</tr>
<tr>
<td>1725</td>
<td>10</td>
<td>26</td>
<td>10</td>
<td>34</td>
<td>While outlining climate policy implementation strategies (under heading Accelerating the global response to climate change) on page 9 of the document, it is essential to focus on &quot;global environmental governance&quot; (GEG). The GEG is the sum of organizations, policy instruments, financing mechanisms, rules, procedures and norms that regulate the processes of global environmental protection. The efficacy of global environmental governance will ultimately depend on implementation at global and domestic levels. [Mishra Santosh Kumar, India]</td>
<td>Accepted - we have refined accordingly</td>
</tr>
<tr>
<td>19190</td>
<td>10</td>
<td>26</td>
<td>10</td>
<td>29</td>
<td>does not allow for free-riding. The formulation is a bit misleading. You want to say, that the target of 1.5 degrees can not be reached with free-riding. Of course, actors can still free-ride on the mitigation efforts of others. Moreover, the sentence seems to contradict p.11 l.44 which says that there is room for same actors to mitigate less than others. [Jaap Meijer, Germany]</td>
<td>Taken into account - we will try to avoid the possible misunderstanding</td>
</tr>
<tr>
<td>5216</td>
<td>10</td>
<td>29</td>
<td>10</td>
<td>33</td>
<td>As the IPCC literature requires concerted action, in multiple forms, across all world regions almost simultaneously, it does not allow for free-riding. Hence, a key governance challenge is how the gains from converging and sustainable developing policies can contribute to the emergence of a world governance based on reciprocity (Clotem and Waelbroeck 2005) and partnership (United Nations 2016a) and how different actors and processes in climate governance can reinforce each other to enable this (Gupta 2014; Anderton et al., 2017). This statement is too broadly drawn clear of becoming policy prescriptive, does come dangerously close to words that promote some form of world governance. The critical few words that are missing here should be words that reinforce the voluntary nature of each nationally determined contribution in the context of the Paris Agreement. [Arthur Lee, United States of America]</td>
<td>Taken into account - we will pay attention not to this impression</td>
</tr>
<tr>
<td>14120</td>
<td>10</td>
<td>29</td>
<td>10</td>
<td>30</td>
<td>free-riding, suggest avoid jargon [Elvira Poloczanska, Poland]</td>
<td>Rejected - because this is a very common expression in economic literature. I do agree with you that it’s just a bit obscure</td>
</tr>
<tr>
<td>19295</td>
<td>10</td>
<td>30</td>
<td>10</td>
<td>35</td>
<td>It may be useful to remind what are SS1 and SS2 for the chapter to stand out [Charlotte Vailles, France]</td>
<td>Accepted - we will do</td>
</tr>
<tr>
<td>7072</td>
<td>10</td>
<td>36</td>
<td>11</td>
<td>31</td>
<td>These are very general descriptions (new literature reaching the same old conclusions), I was hoping for sectorial or regional evaluations, but maybe these are presented later? [Eva Måse, Sweden]</td>
<td>Accepted - Table 4.1 already aims to give some information at the sectoral level, and as our insights in the final version of chapter 2 is improving, we aim to make the text more concrete.</td>
</tr>
<tr>
<td>10549</td>
<td>10</td>
<td>36</td>
<td>13</td>
<td>49</td>
<td>Do not discuss the system. The same socio-economic system that created the problems are being proposed to changed it, with same socio-technical changes. However this is not possible in the long-term. You should discuss more and challenge the current economic system. [José Antonio Pappo de Oliveira, Brazil]</td>
<td>Taken into account. The new section 4.2.2.2 includes a brief discussion on this, although we note that peer-reviewed literature is sparse and the reviewer does not provide sources, unfortunately.</td>
</tr>
<tr>
<td>5736</td>
<td>10</td>
<td>36</td>
<td>16</td>
<td>43</td>
<td>The text in Section 4.2 is all too general and the pathways can be found for adaptation of any level of warming, not just 1.5°C. The text may be condensed in a Table which gives a summary of individual adaptation measures. [Hong Yang, Switzerland]</td>
<td>Accepted - the text on adaptation is made more specific, and on mitigation more sectorally specific.</td>
</tr>
<tr>
<td>20662</td>
<td>10</td>
<td>36</td>
<td>16</td>
<td>43</td>
<td>For section 4.2, align discussion with each of the four pathways presented in chapter 1 to again keep reader focused on the holistic characteristics of each pathway and the implications of them. Without associated the implications with the four types of pathways, they are vague and lose some of their meaning for the reader. [Rocio Yanner, Germany]</td>
<td>Rejected - In chapter 4, we only take the temperature stabilisation and overshoots into account as we are focusing on what needs to be the global response for 1.5°C. In essence, the difference is not fundamental, both will need fast and accelerated action in all possible sectors.</td>
</tr>
</tbody>
</table>
There are also studies that estimate the maximum reductions that can be achieved through implementation of known mitigation technologies in one or more countries over a specified period. A recent example is that of Mark J. Jacobson et al. (2017, 100% clean and renewable wind, solar and wave energy and hydropower in all 10% or higher in a year, Van Sluisveld et al., Italy).

This author should also look to a Board of Trustees, covering here the most recent new technology options of clean technologies in specific countries and sectors in a pace that, if generated to more countries and sectors, would lead to full in aggregate emissions in the range required by the commitments to limit warming to 1.5ºC. In first approximation, papers covering local examples of increase in the stock of clean technologies by 10% or higher in a year. (Valentino Piana, Italy)

Floropat (2016) analyses data until year 2000, with corresponding implied implications for new technologies and sustainable development. (Ethika Meta, New Zealand).


Can't find first paper reference in Menzies (Wille-Muñoz Olea, France).

The year of publication for Gajjar et al. is not given. The same applies to line 2 of page 11. (Victor Ongoma, Kenya).

The acronym IAMS (or IAM) doesn't appear to be defined anywhere. (Jason Donev, Canada)

Do Not Quote, Cite, or Distribute Page 29 of 159
10695
11 41 11 42
We need to address non-overseas and air seepage away because they’re not in the scenario database [Skeie Jim, United Kingdom (of Great Britain and Northern Ireland), Netherlands].

Accepted. Yes, Currently we have only Rogelj et al (2015) for 1.5°C. We expect the new ensemble of scenarios to be available soon will have non-overseas IAM scenarios. We are also looking for non-IAM scenario literature from chapters 3 and 5 to fill this gap.

6732
11 41 11 49
Similar to comments above, despite recognizing that social preference may accelerate the mitigation, the report takes IAMs at face value pointing out that all 5°C pathways show an overshoot and that it will not be reached without sequestration technologies, more prominently BECCS [Jeniffer Morgan, Netherlands].

Rejected. Not true. We are looking at all the scenarios and literature consistent with 1.5°C whether IAM or non-IAM, overshoot or without overshoot. The current assessment is based on the current vintage of IAM reviewed in Rogelj et al (2015). BUT as noted in the first paragraph we are seeking to incorporate the new ensemble from IAM scenarios that may include some without overshoot as well as we are looking into the non-IAM literature from chapters 2, 3 and 5.

16401
11 41 11 44
I think it quite misleading to use the name “1.5°C pathways” for pathways that overshoot 1.5°C but then come back to that value, the names of pathways should be based on the maximum value they reach rather than some eventual/lower number, which is where we should be aiming for all pathways in order to minimize impacts. In particular, it is more accurate to accept overshoot given the severe impacts that will be occurring at the value, especially after having overshot 1.5°C. The case as such reads back to 1.5°C after overshooting will be causing very severe consequences for the leaders of the nations that have suggested this value (i.e., sea level rise that will be on course to be undoing low lying island nations quite possibly before one gets back to 1.5°C). In my view, the notion of 1.5°C that should be the ceiling and effort should be made to get back to 0-0.5°C or so. Thus, where we want a path is a pathway that peaks at 1.5°C and returns to less than 0.5°C, and if the path is going to take conditions up to 2 or 3°C, this has to be noted in the name of the pathway—if we can overshoot and come down to 1.5°C, it would just take more effort on Carbon Dioxide removal. The near-term maximum temperature can be moderated by Solar Radiation Management, an important option to be discussing. So, there are lots of pathways—and let’s name them by the maximum increase that they reach and that will be a key determinant of the damage done, even if the temperature later cools down [Michael MacCracken, United States of America].

16730
11 44 11 43
The main characteristics of 1.5°C pathways can be summarized as follows: they are below the emissions pathways of RCP8.5 in AR4 and all feature temperature overshoot. Global GHG emissions will need to decrease from the current ca. 50 GtCO2 eq-1 to become net zero by mid-century and net negative thereafter. Why? We assume only scenarios that global GHG emissions become net zero by mid-century (or by 2050 as later stated) and then the need for significant net negative emissions? Are scenarios becoming net zero much earlier than mid-century actually considered (and much less need for negative emissions)? [Jeniffer Morgan, Netherlands].

Accepted. Accepted. Sentence deleted.

4893
11 44 11 45
These statements, in particular the word “imply” that large emitters, and regions and cities with high emissions, will need to achieve net-zero emissions by the 2050s...[Jennifer Morgan, Netherlands].

Accepted. Sentence deleted.

2235
11 45 11 46
Why do those particular emitters need to achieve net-zero by 2050? Really, the determining factor is how the global emissions develop and to what extent one or several individual emitters need to reach net-zero by a certain time must depend on how the sum of all global emissions develop. [Jennaline McIntyre, Sweden].

Accepted. Sentence deleted.

5116
11 45 11 49
Given the scale of concern about the efficacy, feasibility, and appropriateness (and potential harm) of BECCS (and the initial discussion of concerns and potential harm in Chapter 3.7.2, it is important to flag that here, even if discussed in greater detail later in the chapter. [Tonya Taube, United States of America]

Rejected. Our assessment is based on the literature and models assessed by chapter 2. Indeed there are more options to remove carbon besides BECCs and that we are not preferring one over the other and fairly assess them all in section 4.3.6

7074
11 48
Are IAMs needed to arrive at such an evident conclusion? [Erica Mateu, Sweden].

Accepted. Not necessary, but the available literature is a mostly similar

16404
11 48
It really does seem to me that additional CDR approaches merit consideration, especially as the costs of further mitigation and of impacts increase so higher CDR costs, including direct air capture become cost effective. I also think that SRM needs to be listed here as an option for peak shaving.so not the other and fairly assess them all in section 4.3.6.

Accepted. Accepted. Sentence deleted.

6731
11 51
Almost the entire accrued abatement potential for non-CO2 GHGs is already exhausted in 2°C scenarios, so few additional reductions are possible in the 1.5°C pathways. This is also true for e.g. methane emissions from agriculture — livestock, oil/gas extraction/transportation, wastewater management? [Jeniffer Morgan, Netherlands].

Accepted. Statement revised

6788
11 51 12 12
The statement that there is no room for energy demand increase is incorrect. This holds only true if the increase comes from fossil fuels and should be spelled out. If the increased energy demand is supplied by carbon neutral energy sources, the demand can increase, [Arnulf Jaeger-Waldau, Italy].

Accepted. Statement revised.

6799
11 51 12 12
No energy source is “carbon-free” but low carbon or carbon neutral made relevant, [Arnulf Jaeger-Waldau, Italy].

Accepted. WIll consider use the term “low carbon” than “carbon-free”

6790
11 51 12 12
Why do we ignore potential of synthetic fuels made out of CO2 from the atmosphere and renewable energy? [Arnulf Jaeger-Waldau, Italy].

Accepted. Submission 4.3.6 deals specifically with the different CDR technology options including their potentials and costs while subsection 4.3.7 deals with SRM in details.

6971
11 51 12 12
Energy related GHG emissions are only 26% of total emissions. Another 26% are industry and 17% agriculture. If the industry should be decarbonised, biomass will be necessary as raw material and will not be available for energy use, [Arnulf Jaeger-Waldau, Italy].

Accepted. Statement revised.

4810
11 52 11 54
The statement “There is almost no room for growth in energy demand” should be rather qualified as “There is almost no room for growth in energy demand covered by emission-reducing carbon sources.” If a certain source of energy does not emit GHG why would it need to be counted in CDR?

Accepted. Sentence revised.

18702
11 53
Scenarios to 450 represents a 30% increase, which seems large enough not to refer to this as “almost no room for growth” [Winfried Menzoula, Czech, France].

Accepted. Sentence revised.
Comment No | From Page | From Line | To Page | To Line  | Comment | Response
--- | --- | --- | --- | --- | --- | ---
7332 | 11 | 54 | 11 | 55 | Delete the text "If left unmanaged, this could have significant implications for the achievement of SDG7 on universal affordable access to clean energy by 2030, and potential limits to the reduction in poverty in Israel" [Elad Kadi, Australia] | Accepted. Sentence deleted
20621 | 12 | 1 | 12 | 1 | Synthetic fuels from recycled CO2 need to be considered [Hans Pfornert, Germany] | Accepted. The CCSU applications as fuel and other uses are discussed in other subsections of the chapter (see section 4.3)
17231 | 12 | 1 | 12 | 1 | Fuel intensive" instead of "fuel intensive" [Simone Gupta, India] | Accepted. Sentence revised
7333 | 12 | 1 | 12 | 1 | Delete the text "fuel intensive economies and regions." [Elad Kadi, Australia] | Accepted. Sentence deleted
14908 | 12 | 4 | 12 | 4 | The paragraph - this chapter? [Pål Rønning, United States of America] | Accepted. Fixed
18402 | 12 | 5 | 12 | 5 | The paragraph or this section? [Michael Jacobson, United States of America] | Accepted. Fixed
10914 | 12 | 7 | | | The statement is either clearly wrong. There won’t be a “massive increase in electricity for transport”. Situation in Switzerland and UK have given results of 10-15 % increase in electricity consumption for electric cars. However electricity use from well-to-car must be subtracted. DOE (Department of Energy) estimated in 2010 "6 kWh per Gallon" for refining. A number confirmed by various industry sources, which gives around 1.5 kWh per liter. Add transport, pumping, electricity for distribution in gas stations instead of at home or work for almost 0.5 kWh per liter. Total 2.0 kWh/liter of electricity to transport the fuel, not counting cooling. For CO2 and other CO2 indirect impacts, a liter gas has 10 kWh primary energy, mechanical and energy of a liter is 1.5-2 kWh, which is the same the electricity used to produce the gas. Thus if we convert whole kerosene and air transportation to battery-powered electricity, and shut down the corresponding fuel production, we will not consume any more electricity. For shipping industry, heavy fuel might not use as much electricity, but shipping industry can convert to wind/PV-electricity, not consuming more electricity from the grid than what gets saved. See Jacobson’s study too. The above remark should intro added to the report, as it is fundamental to debunk the general belief that EVs will increase electricity use. [Beat Brüner, Switzerland] | Accepted. Sentence revised
18403 | 12 | 7 | 12 | 8 | The sentence does not really make sense, at least to me. [Michael Jacobson, United States of America] | Accepted. Sentence revised
481 | 12 | 7 | 12 | 8 | The author should be more clear in underlining second-generation biofuels and biomethane, which have significant less conflicts with food production. Accordingly, the sentence “in general below” could be integrated with “… in general below”, including bio-methane and second generation biofuels”. [Valentino Piana, Italy] | Accepted. Sentence revised
3071 | 12 | 7 | 12 | 8 | I do not see the connection between the first and last halves of the sentence starting with “Furthermore...” [Christopher Bataille, Canada] | Accepted. The sentence is deleted
4812 | 12 | 9 | 12 | 10 | The author should be more clear in underlining second-generation biofuels and biomethane, which have significant less conflicts with food production. Accordingly, the sentence “… in general below” could be integrated with “… in general below”, including bio-methane and second generation biofuels”. [Valentino Piana, Italy] | Accepted. Sentence revised
7075 | 12 | 10 | 12 | 10 | Lower emission reaches higher reduction rates, right? [Érika Mata, Sweden] | Accepted. Sentence revised
11143 | 12 | 10 | 12 | 12 | 1.5°C scenario feature reduction rates of 25% and 50% lower than for 2°C respectively - this implies that the rates of emission reductions are lower for 1.5°C i.e. slower reductions. [Michel Scharlemann, Netherlands] | Accepted. The revised version included a table on sectoral targets. Regional details are not there yet and will depend on availability and consistency of results from the forthcoming IAM and non-IAM scenarios literature from chapter 2
12945 | 12 | 18 | 12 | 39 | Climate resilient pathway. 52% has climate resilient development pathways - there is need for coordination. Also mentions of SSPs as in ch 2. Ch 5 and subdiscusses respective concepts and pathways in details so here can’t be dropped with appropriate references? [Jayashree Roy, India] | Accepted. Subsection removed and discussion deferred to chapter 5
20822 | 12 | 30 | 12 | 30 | under how mitigation success is achieved in the SSPs [Hans Pfornert, Germany] | Accepted. Section revised to remove ambiguity
545 | 12 | 30 | 12 | 30 | The emission pathways form the IAM literature. This section would benefit from discussing the prior and more comprehensive literature on solution pathways to global warming, including the 100% clean, renewable wind, water, solar (WWS) pathways of Jacobson, Delucchi et al. published in the documents below, which call for 80% conversion to WWS in all energy sectors by 2030 and 100% by 2050. This transition is shown in http://web.stanford.edu/group/efmh/jacobson/Articles/Policy/CountryGraph/CFSChangesWithWWS.pdf which is found in Figure 2 of Jacobson et al. [Joule, 1, 1, 2017] (Jacobson et al. Vol 1, 2017) cited below. Such a transition is found to reduce CO2 levels in the atmosphere to almost 350 ppm by 2100 (http://web.stanford.edu/group/efmh/jacobson/Articles/Policy/CountryGraph/CFSChangesWithWWS.pdf) [Mark Jacobson, United States of America]. | Accepted. Results from the suggested references are reflected.
547 | 12 | 30 | 12 | 30 | The emission pathways form the IAM literature. This section would benefit from discussing the prior and more comprehensive literature on solution pathways to global warming, including the 100% clean, renewable wind, water, solar (WWS) pathways of Jacobson, Delucchi et al. published in the documents below, which call for 80% conversion to WWS in all energy sectors by 2030 and 100% by 2050. This transition is shown in http://web.stanford.edu/group/efmh/jacobson/Articles/Policy/CountryGraph/CFSChangesWithWWS.pdf which is found in Figure 2 of Jacobson et al. [Joule, 1, 1, 2017] (Jacobson et al. Vol 1, 2017) cited below. Such a transition is found to reduce CO2 levels in the atmosphere to almost 350 ppm by 2100 (http://web.stanford.edu/group/efmh/jacobson/Articles/Policy/CountryGraph/CFSChangesWithWWS.pdf) [Mark Jacobson, United States of America]. | Accepted. The references are added to Mendeley and will be considered for citation

IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4
Comment No  From Page  From Line  To Page  To Line  Comment  Response
551  12  30  12  30  (9) Jacthomen, M.Z.; M.A. Delucchi, G. Bazian, Z.A.F. Bauer, C.C. Haney, E. Fisher, S. B. Morris, G.Y. Paltokovych, T.A. Versil, T.W. Yektan, 100% clean and renewable wind, water, sunlight for the 50 United states and 92% for the 168 countries of the world. (WWS) all-sector energy roadmaps for the 50 United states. Energy and Environmental Sciences, 8, 2035-2117, doi:10.1038/EE20358; 2015a [Mark, Jacqueline, United States of America]  Accepted. The references are added to Mendeley and will be considered for citation
554  12  30  12  30  (9) Jacthomen, M.Z.; M.A. Delucchi, M.A. Cameron, and B.A. Free. A low-cost solution to the grid reliability problem with 100% penetration of intermittent wind, water, and solar for all purposes, Proc. Nat. Acad. Sci., 112 (49), 15,060-15,065 doi: 10.1073/pnas.1510028112, 2015b [Mark, Jacqueline, United States of America]  Accepted. The references are added to Mendeley and will be considered for citation
10997  12  35  12  35  Treatment of the SSPs is opaque for the non-technical (Steele Jim, United Kingdom [of Great Britain and Northern Ireland])  Accepted. SSPSs are introduced and defined in chapter 2. The objective here is to take stock of their implications for mitigation, adaptation, and impacts. More referencing to that extent is now reflected.
3072  12  37  12  37  In discussion of non-IAM literature, it could be helpful to quote the exact value of the factors that prompt inclusion of particular approaches like BECCS. (e.g. cost of land assumed to be available for BECCS to be at a scale) Why is BECCS so prominent in IAMs as a “feasible” technology? What factors were not considered? These are important questions to include discussion of: given how much promise is now being put into BECCS, when others are raising serious questions about the feasibility – socially as well as technologically – of BECCS. [Tonga Rane, United States of America]  Accepted. The reference provided is added to Mendeley and will be considered for citation. The DDPP project has already been referred to in the box in section 4.4 as well on policy cases.
4813  12  37  12  39  For an example of non-IAM relevant literature, see Jacthomen et al. 100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-Sector Energy Roadmaps for 139 Countries of the World. Joule, 2017 DOI: 10.1016/j.joule.2017.07.005
See also REN21 Renewable Global Futures Reports, 2017; [Valentine Parke, Italy]  Accepted. Reference added and results are cited
5117  12  37  12  39  In discussion of non-IAM literature, it could be helpful to quote the exact value of the factors that prompt inclusion of particular approaches like BECCS. (e.g. cost of land assumed to be available for BECCS to be at a scale) Why is BECCS so prominent in IAMs as a “feasible” technology? What factors were not considered? These are important questions to include discussion of: given how much promise is now being put into BECCS, when others are raising serious questions about the feasibility – socially as well as technologically – of BECCS. [Tonga Rane, United States of America]  Accepted. The scope, potential and feasibility of BECCS are discussed in section 4.3.
19715  12  42  12  45  Need to explore the implications of 1.5 pathways on human rights. The issue is unpacked in the publication listed in the line above. [Tara Shine, Ireland]  Accepted. Based on availability of 1% relevant literature, the human rights dimension is treated under governance and SD in other sections of the chapter as well as in chapter 5
3615  12  43  12  45  Feasibility is meaning – vs scale, implications for adaptation and implications for policy-making but where is feasibility? [Stewart Field, Canada]  Accepted. Feasibility is treated in section 4.3, particularly see 4.3.1.
7107  12  51  12  52  Is there other literature – specific for the 1.5 to 2C comparison – than the WWU in such a short timeframe? [Erika Mata, Sweden]  Accepted. The references provided are added to Mendeley and will be considered for citation.
1122  12  52  12  52  Not only energy and lifestyles, also in other areas (industry, finance, other factors were not considered? These are important questions to include discussion of: given how much promise is now being put into BECCS, when others are raising serious questions about the feasibility – socially as well as technologically – of BECCS. [Tonga Rane, United States of America]  Accepted. The references are added to Mendeley and will be considered for citation.
7078  12  52  12  52  I do not remember the specific investment requirement from Chapter 3, but anyway, is a relative investment useful if I invest useful at all given the uncertainties related to costs (see comment in row 39 above)? May it be more useful to set reduction targets an investigate with other - non IAMs - tools how to achieve them? [Erika Mata, Sweden]  Accepted. Cited investment number from chapter 2 is correct. It is true that both investment costs and mitigation outcomes are relevant when comparing IAMs with non-IAM pathways. Nonetheless, we are constrained to assess what the literature says
7797  12  52  12  54  This statement is almost certainly incorrect: I assume Chapter 2 draws it from the same outdated reference as 4.2.3.4 does. [Amy Lovins, United States of America]  Accepted. The references are added to Mendeley and will be considered for citation.
7799  12  52  12  54  This statement is almost certainly incorrect: I assume Chapter 2 draws it from the same outdated reference as 4.2.3.4 does. [Amy Lovins, United States of America]  Accepted. The references are added to Mendeley and will be considered for citation.
17758  12  52  12  54  Please see my comment on p.4-36年轻的16-14。[Amy Lovins, United States of America]  Noted.
17902  12  52  12  54  This statement is almost certainly incorrect: I assume Chapter 2 draws it from the same outdated reference as 4.2.3.4 does. Please see my comment on p.4-15, lines 9-14. [Amy Lovins, United States of America]  Noted.
7651  12  52  12  54  This statement is almost certainly incorrect: I assume Chapter 2 draws it from the same outdated reference as 4.2.3.4 does. [Amy Lovins, United States of America]  Noted.
7653  12  52  12  54  Please see my comment on p.4-36年轻的16-14。[Amy Lovins, United States of America]  Noted.
7656  12  52  12  54  This statement is almost certainly incorrect: I assume Chapter 2 draws it from the same outdated reference as 4.2.3.4 does. Please see my comment on p.4-15, lines 9-14. [Amy Lovins, United States of America]  Noted.
1123  12  53  12  53  More investments, or “difficult” investments? 47% more with without temperature target, which seems to refer to some unknown BAF. But a BAF is undefined and can be anything... Change or in any case add reference. [Rob Swart, Netherlands]  Accepted. Referencing to chapter 2 added.
4814  12  11  13  11  A misleading projection should be developed to evaluate the investment necessary to handle the outcomes of these significant increases in temperature and precipitation (infrastructure destruction, health hazards, etc) and compare and contrast this projected incremental management investment to the investment necessary to prevent such from happening. Such a comparative perspective might induce higher approval for precautionary investment. [Yana Popovskova, France]  Accepted. The framing question is addressed in chapter 1. The relevance to NDCs is dealt with in a different section of chapter 4 and in the chapter box on NDCs.
9841  13  5  13  5  Notice that we linked to Mendeley (Withen Mordumana Chea, France) Accepted.
34

13

13

27

The paragraph is disappointing and it aims to provide for a very good campaign against the need of acceleration of efforts to remain below 1.5°C. It also asks the avoided climate impacts of delaying 2°C to 1.5°C or warming 2°C to 1.5°C to delay the effects of climate change and allocate higher investment to an effort. It does not add any knowledge, facts or arguments and is a patch to a section which is basically factual pernicious on the preference and feasibility of changing to 1.5°C. This paragraph should be deleted. [Yane POPKOSTOVA, France]

Accepted. The objective here is not to persuade for the urgency or feasibility of 1.5°C but rather to provide a balanced assessment of its implications. Section revised and emphasis is made more clear.

1920

13

17

17

Why “some literature”? Is there any literature suggesting otherwise? [Oliver Geden, Germany]

Accepted. All examples are now removed from the section due to space.

1870

13

17

17

About 10 cm should be “minimum 10 cm”, and “estimated 50 cm” should be “estimated minimum 50 cm” [Beat Brunner, Switzerland]

Accepted. Sentence fixed.

1091

13

28

The paragraph directly negates the statement made in the paragraph co-occur line 7. Here, we can certainly observe that median water availability changes dramatically between 1.5 and 2°C scenario. [Yane POPKOSTOVA, France]

Accepted. There is no contradiction. The earlier statement relates to the broader IAM literature (typical on model inter-comparisons) while the latter is specific to a single study. The forthcoming literature is expected to provide more insights into this issue.

1041

13

27

To note that 50 cm rise by 2100 for a 2°C scenario is an conservative (optimistic) estimate, not taking in account unverified hypotheses (like speed of Greenland melting). Thus, the difference with 1.5°C could be significantly more than 10 cm (which represents a 20% increase in projected rise for a 33% increase in global temperature) [Beat Brunner, Switzerland]

Accepted.

11402

13

30

49

Decision-making is strongly affected by “politics”, in every governance dimension, on any level. See, among others, Brunner 2009 [The consequences of decision-making]. Geden 2015b [The Paris Agreement and the inherent inconsistency of climate policymaking]; Cairney 2016 [The politics of evidence-based policymaking]; Victor 2013 [Global Warming Gridlock]; Vogel 2015 [Climate Change in World Politics] [Geden, Switzerland]

Rejected. The provided references are added to the database. The politics, governance and institutions behind decision making are dealt with in other sections of the chapter (e.g. section 4.4).

5118

13

30

36

And does other literature offer a different take on the level of measures, costs, and efforts required, to present a balanced picture of the literature? And to what may appear to be an obvious statement? [Yane POPKOSTOVA, France]

Accepted. Sentence revised.

19297

13

34

36

What is “the mitigation cost”? Is there any literature suggesting otherwise? [Oliver Geden, Germany]

Accepted. References are added to the database. Referencing to relevant sections of chapter 2 is added.

19298

13

34

36

The avoided impacts of a lower warming seem difficult to neglect [Charlotte Vailles, France]

Accepted. Sentence revised.

4815

13

25

A crucial piece of literature to be quoted here is D-Hoff. S. et al. Catalogue of abrupt shifts in Intergovernmental Panel on Climate Change models. Proc. Natl. Acad. Sci. 2015:145 (2015) which demonstrates that “20% of thresholds of abrupt shifts crossed for 1.5°C compared to 50% at 2°C”.

Noted.

10916

13

27

To be noted that 50 cm rise by 2100 for a 2°C scenario is an conservative (optimistic) estimate, not taking in account unverified hypotheses (like speed of Greenland melting). Thus, the difference with 1.5°C could be significantly more than 10 cm (which represents a 20% increase in projected rise for a 33% increase in global temperature) [Beat Brunner, Switzerland]

Noted.

11042

13

30

49

Decision-making is strongly affected by “politics”, in every governance dimension, on any level. See, among others, Brunner 2009 [The consequences of decision-making]. Geden 2015b [The Paris Agreement and the inherent inconsistency of climate policymaking]; Cairney 2016 [The politics of evidence-based policymaking]; Victor 2013 [Global Warming Gridlock]; Vogel 2015 [Climate Change in World Politics] [Geden, Switzerland]

Rejected. The provided references are added to the database. The politics, governance and institutions behind decision making are dealt with in other sections of the chapter (e.g. section 4.4).

5118

13

30

36

And does other literature offer a different take on the level of measures, costs, and efforts required, to present a balanced picture of the literature? And to what may appear to be an obvious statement? [Yane POPKOSTOVA, France]

Accepted. Sentence revised.

19297

13

34

36

What is “the mitigation cost”? Is there any literature suggesting otherwise? [Oliver Geden, Germany]

Accepted. References are added to the database. Referencing to relevant sections of chapter 2 is added.

19298

13

34

36

The avoided impacts of a lower warming seem difficult to neglect [Charlotte Vailles, France]

Accepted. Sentence revised.

4815

13

25

A crucial piece of literature to be quoted here is D-Hoff. S. et al. Catalogue of abrupt shifts in Intergovernmental Panel on Climate Change models. Proc. Natl. Acad. Sci. 2015:145 (2015) which demonstrates that “20% of thresholds of abrupt shifts crossed for 1.5°C compared to 50% at 2°C”.

Noted.

10916

13

27

To be noted that 50 cm rise by 2100 for a 2°C scenario is an conservative (optimistic) estimate, not taking in account unverified hypotheses (like speed of Greenland melting). Thus, the difference with 1.5°C could be significantly more than 10 cm (which represents a 20% increase in projected rise for a 33% increase in global temperature) [Beat Brunner, Switzerland]

Noted.

11042

13

30

49

Decision-making is strongly affected by “politics”, in every governance dimension, on any level. See, among others, Brunner 2009 [The consequences of decision-making]. Geden 2015b [The Paris Agreement and the inherent inconsistency of climate policymaking]; Cairney 2016 [The politics of evidence-based policymaking]; Victor 2013 [Global Warming Gridlock]; Vogel 2015 [Climate Change in World Politics] [Geden, Switzerland]

Rejected. The provided references are added to the database. The politics, governance and institutions behind decision making are dealt with in other sections of the chapter (e.g. section 4.4).

5118

13

30

36

And does other literature offer a different take on the level of measures, costs, and efforts required, to present a balanced picture of the literature? And to what may appear to be an obvious statement? [Yane POPKOSTOVA, France]

Accepted. Sentence revised.

19297

13

34

36

What is “the mitigation cost”? Is there any literature suggesting otherwise? [Oliver Geden, Germany]

Accepted. References are added to the database. Referencing to relevant sections of chapter 2 is added.

19298

13

34

36

The avoided impacts of a lower warming seem difficult to neglect [Charlotte Vailles, France]

Accepted. Sentence revised.
### Comment Response - Chapter 4

#### Comment No 12410

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comment:** Not sure whether in this assessment section 4.2.3 is entirely necessary. This is not assessing the literature in the context of the objective of the chapter. [Dr Noim UDDIN, Australia]

**Response:** Rejected, discussion of framing systemic issues was an IPCC request, and thus part of our mandate.

#### Comment No 14074

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>1</td>
<td>14</td>
<td>3</td>
</tr>
</tbody>
</table>

**Comment:** The section deals mainly with mitigation and only occasionally with adaptation. In fact, some of the sections do not mention adaptation at all. This should be more balanced, or at least made clear in the introduction of the subchapter. [Irina Polshuk, Romania, Germany]

**Response:** Taken into account – we deleted 4.2.3 so no longer relevant.

#### Comment No 14999

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>1</td>
<td>14</td>
<td>4</td>
</tr>
</tbody>
</table>

**Comment:** I would consider three buckets here, social, technological, and financial innovation. Disruptive and socio-technical innovation is fine, but financial innovation is missing – i.e., new financial instruments/mechanisms/models to provide climate finance. In the innovation discussion, it could also be helpful to reference the cross-cutting concept of National Systems of Innovation (TEC brief #7 – unfccc.info/tecnovasi, /stats/TEC-605158274414075585a050664d780.pdf) [Farhan Akhtar, United States of America]

**Response:** Taken into account, financial systems are discussed in 4.4.6.

#### Comment No 19071

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>1</td>
<td>16</td>
<td>43</td>
</tr>
</tbody>
</table>

**Comment:** Writing about “radical transition” “Disruptive innovation” and “Socio-technical innovation” order “4.2.3 Framing systemic issues: resilient economic systems, social systems, innovation systems […]” would require a mention to Giovanni Dosi’s concept of “technological paradigm”, which is fully comprehensive and suitable concept to this section. It will be suggested to include a reference e.g., Dosi, G. (1982). Technological Paradigms and Technological Trajectories. A Suggested Interpretation of the Determinants and Directions of Technical Change. Research Policy 11, 147-162, reference also available as Dosi, G., & Nelson, R. R. (2016). Technological paradigms and technological trajectories. The Palgrave Encyclopedia of Strategic Management, 1-12 [Miriam Solera Ureña, Germany]

**Response:** Taken into account, we included more recent references on socio-technical innovation that covers Dosi’s work.

#### Comment No 19073

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>1</td>
<td>16</td>
<td>43</td>
</tr>
</tbody>
</table>

**Comment:** When framing systemic issues, it would be recommended to include a reference to developed-developing countries solidarity, such as technology and know-how transfer to developing countries in order to improve their resilience [Miriam Solera Ureña, Germany]

**Response:** Taken into account, solidarity issues are discussed in Chapter 5, see Box 5.4 ‘Alternative Development Pathways and Transnational Movements’

#### Comment No 20624

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>1</td>
<td>16</td>
<td>43</td>
</tr>
</tbody>
</table>

**Comment:** While the discussion of principles in transformation and effort is much appreciated, policy makers would appreciate a quantitative assessment of effort for 1.5 C-2 C if at all possible. [Herko Poerstorfer, Germany]

**Response:** Taken into account, included where possible.

#### Comment No 16405

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>4</td>
<td>14</td>
<td>10</td>
</tr>
</tbody>
</table>

**Comment:** Given the representation of the goal of the Paris Agreement is to stay “well below 2 C temperature rise, or below 1.5 C” – how is it that so much of this report is focused around an end goal of stabilization at one of these two levels? Precisely clearly, the goal is to not be having severe impacts and there will be very significant impacts at these levels and commitments to much greater impacts over time as sea level continues to rise, etc. I just do not see how focusing on 1.5 C equilibrium pathway after overshoots is consistent with the goal the negotiations are taking about – they quite clearly want any overshoot to come back to at least below 1.5 C (and if informed of the consequences at this level, would prefer to be back below 0.5 C). So, again, why focusing on stabilization at 1.5 C (and framing pathways to get only to this level)? [Michael MacCracken, United States of America]

**Response:** Taken into account, this report aims to impact of global warming of 1.5C and related GHG emission pathways, which is the mandate of this report - see section 1.2

#### Comment No 4816

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>4</td>
<td>14</td>
<td>18</td>
</tr>
</tbody>
</table>

**Comment:** Before the paragraph on Disruptive innovation, the author should insert a paragraph on “Fast diffusion of existing state-of-art clean technologies” indeed many zero emission technologies exist, several countries are already at- or near- 100% renewables and zero-erosions (land cover included), thus copying text-in-class examples would highly impact total emissions. In the timeframe of the exhaustion of the carbon budget of 1.5C, there may be not enough time for totally new technologies to ramp up market penetration in a way that makes the difference. The two classes of technologies should not be opposed to each other but both included in the chapter. [Valentino Piane, Italy]

**Response:** Accepted and noted (eg. We refer to roof top solar, energy storage in section 4.2.3.1)

#### Comment No 19716

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>6</td>
<td>14</td>
<td>10</td>
</tr>
</tbody>
</table>

**Comment:** Human rights law is a useful framework when considering social issues. [Tara Shine, Ireland]

**Response:** Taken into account, Chapter 5 makes reference to human rights as part of climate-resilient development pathways (section 5.7.3.2).

#### Comment No 5537

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>6</td>
<td>14</td>
<td>7</td>
</tr>
</tbody>
</table>

**Comment:** 1.5C cannot be achieved using climate mitigation alone. This claims is contradicted directly by the 2018 USWSS roadmap referenced above plus the resulting CO2 levels shown in http://web.stanford.edu/group/eemh/jacobson/Articles/CO2ChangesWithWWS.pdf [Mark Jacobson, United States of America]

**Response:** Accepted, we removed the text ‘cannot be achieved using climate mitigation policy alone, and...

#### Comment No 6734

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>13</td>
<td>14</td>
<td>30</td>
</tr>
</tbody>
</table>

**Comment:** These 3 short para’s seem to miss the scale of disruptive impact of existing technologies (e.g. established renewable technologies, existing storage solutions and grid solutions etc); the significance of emerging technologies (e.g. new renewable technologies, new storage solutions); such large cross-cutting technologies like biochar etc and - what is perhaps the most important - the combination interplay of all of these above in helping to reduce emissions. [Jennifer Morgan, Netherlands]

**Response:** Accepted and noted (eg. We refer to roof top solar, energy storage in section 4.2.3.1)

#### Comment No 10549

<table>
<thead>
<tr>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>13</td>
<td>14</td>
<td>44</td>
</tr>
</tbody>
</table>

**Comment:** The discussion of the idea of disruptive innovation need do be more socially and politically embedded. Firms have no interest in disruptive sustainable innovation, except if they will profit from that, which many times comes with losses for the rest of the society. You should move beyond the mainstream neoclassical economics to challenge the discussions on innovation beyond the Scumpeterian views. [Jose Antonio Puppim de Oliveira, Brazil]

**Response:** Accepted, governance and institutional capacities are discussed in 4.4.
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
7893 | 14 | 13 | 14 | 30 | Include references / mention of the developments of a global Circular Economy and transition from a Linear to a Circular system (e.g. Siemens and the Industry 4.0 movement). Valuable examples of solutions to combating GHG emissions is evident in the industry sector. Companies need to be approached by government bodies in an effort to develop more dynamic interaction and consult with them on the whole issue of eco-design and design for recovery and recyclability at the beginning.Recycle of a product or piece of infrastructure Increasingly, companies from all sectors are having to confront and adapt to a range of disruptive forces including globalisation, increased urbanisation, increased competition for raw materials and natural resources and the resolution in technology is challenging the business models of many sectors while forcing all companies to be more accountable to, and transparent with, all their stakeholders. A Circular Economy model provides for embedded goals of the SDGs (including combating climate change - Mitigation and Adaptation) to be addressed from the beginning of the value loop. | Taken into account, industrial systems are now discussed in 4.3.5

- Technology enhances the flexibility and efficiency of production processes. Companies like Siemens are working toward the complete integration and digital representation of the physical manufacturing environments. This means working on and in virtual copies of manufacturing sites (a little like a computer gaming environment) - prior to the actual installation of any hardware or devices on the factory floor.
- The Digitisation of businesses will help to support the regenerative, optimising and exchange environment for a CE. The
- Developments in technologies and services help companies to reduce the consumption of energy and natural resources by optimising the processes of manufacturing,  keeping the processes, and reducing wasted energy, materials and efforts. And these aspects are accomplished through the digitalisation, electrification and automation of industrial systems - if the systemic enabling of technology, IoT, using Artificial Intelligence to think and predict the processes stages in an effort to operate business more efficiently and thus reduce negative environmental impacts.
- Business environments operate through and with mountains of data which informs all that they do in the various divisions of business operations. The data indicates trends and movements for men goals, aspirations and project work.
- Digital Factories solutions / virtual design mechanisms (IoT) Industry 4.0 / Energy Performance contracting services businesses are all endeavours that are helping to inform the development of a more sustainable circular economy. Other examples in businesses already experimenting and developing within the Sharing Economy space include what is a commonplace 'real-time cropping' (shared services)renting of spare rooms (airbnb) activities etc and insight and lessons learned (the good and the bad) from new and digitised businesses facilitated through the use of apps on smartphones, and their approaches, can be used to help guide the more traditional businesses to transform to the CE approach.
- A major consideration in looking at the CE is the Pace of Change in technology and specific indicators like a return on development or R&D per metric or annual application software systems uptake by new products. These are able to inform a company (and government / research institutes etc) through collaboration of the learning changes in working habits. The ability to interpret information, and the closer integration of data systems across connected devices and across multiple sources is crucial to streamlining the digitisation evolution. Recently there have been technological developments in software platforms (Cloude for the industry sector) and allows connectivity among devices and pieces of hardware across varied data sources to harness key information for better industrial operators and; and the value to a company is in the ability of a company to change and streamline the operational flows and reduce its emissions.
- A factory that is able to maximise cost advantage by adjusting its production output to current resource prices without human intervention is offered by technological solutions that have several gaps in practice. First the pollicacy/circular economy gap. Will it really happen? If there is no political support which many times does not exist, as the powerful economic actors, like oil and construction companies, have much more power than those that want the transition. Second, the socio-technical transitions assume that the capabilities exist in many countries, particularly developing countries. (Jose Antonio Pusumo de Oliveira, Brazil) | Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, industrial systems are now discussed in 4.3.5
- Taken into account, disruptive and socio technical innovations are not necessarily related, so there is no hierarchy

10550 | 14 | 13 | 14 | 44 | Socio-technical transitions discussion has several gaps in practice. First the policy/circular economy gap. It will truly happen? If there is no political support which many times does not exist, as the powerful economic actors, like oil and construction companies, have much more power than those that want the transition. Second, the socio-technical transitions assume that the capabilities exist in many countries, particularly developing countries. (Jose Antonio Pusumo de Oliveira, Brazil) | Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, industrial systems are now discussed in 4.3.5
- Taken into account, disruptive and socio technical innovations are not necessarily related, so there is no hierarchy

6201 | 14 | 13 | 14 | 64 | It seems to me the logical sequence is to reverse these two subsections. i.e. the principal point here is that it is to think about 1.5°C entail thinking about a major socio-technical transition. The transition socio-technical literature tells us various things about this. One of these is that innovation that shifts systems from one state to another is disruptive, and often leads to existing assets being stranded. In deed it seems to me then that the other subsections in this section follow logically as different elements are important to shaping transitions (finance, policy, etc) [Matthew Paterson, United Kingdom of Great Britain and Northern Ireland]) | Taken into account, reference is a news article

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

6735 | 14 | 14 | 14 | 30 | Focused to have included a section (albeit brief) on disruption. However, for more discussion is needed on the topics to flush out the true potential of disruption to accelerate the pace of change beyond technological trends and beyond what traditional modeling approaches have predicted. This is especially critical in light of the rapid need to transform the energy system and the risks and costs associated with relying on CDR approaches. The RMI report, Positive Disruption, outlines the ways in which solar, batteries and other renewable energy solutions are disruptive solutions that can result in non-linear changes in the energy system thus making it possible to limit warming below 2 degrees without using CDR approaches. What's more, this section
- Taken into account, reference is a news article
- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

19388 | 14 | 14 | 14 | 20 | Positive disruption is mentioned as a potential source of systems change, towards climate mitigation. Positive innovations in the energy sector have been mentioned, as there a desirable rate of adoption of disruptive technologies? (Sumita Palucka Gujar, India) | Taken into account, a key characteristic of disruptive change is that it is not predictable. There is no literature linking this literature to modelling reported in chapter 2

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

18592 | 14 | 15 | 14 | 15 | ClimateBank (1997) not to be mentioned (William Middelkoop, Oslo, France) | Editorial

7901 | 14 | 16 | 14 | 20 | It is not just the gross climate finance that the the MDBs and national development banks are delivering, but net climate finance, which includes 'brown' | Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

20827 | 14 | 18 | 14 | 21 | It is not just the gross climate finance that the the MDBs and national development banks are delivering, but net climate finance, which includes ‘brown’ | Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world

- Taken into account, this in 4.4. Socio-technical innovation happens all across the world
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1383</td>
<td>14</td>
<td>18</td>
<td>72</td>
<td>7</td>
<td>I like a lot the research from Newman, and agree with the arguments supported by references to it, however it would be beneficial for the robustness of the arguments in the draft to provide a larger diversity of authors and works supporting the arguments currently referred to the large number of citations to Newman’s work. [Rogier Cremaud, Germany]</td>
<td>Taken into account, other references are included</td>
</tr>
<tr>
<td>15461</td>
<td>14</td>
<td>20</td>
<td>14</td>
<td>24</td>
<td>Would just add that in the energy field there has not until recently been the incentive or capital to bring alternative fossil fuels to the market. With the increasing pressure to do so, there are all sorts of potential approaches that could contribute that just need to be fostered. For example, battery technology in recharging electric vehicles and once there is a shift to ultra-capacitor batteries that do not rely on chemical reactions, the obstacles of unacceptably long recharge times and of limiting them to 1000 cycles or so will be overcome, and so the transportation central of those now coming of age in developing nations of south Asia and Africa will be able to be met in much easier and less costly and impactful ways that building up the infrastructure for long-term continuance of use of petroleum (for an example of emerging progress, see <a href="http://www.microtrontec.com">http://www.microtrontec.com</a>). And, of course, solar and wind technologies are becoming far less costly and their use has many indirect benefits as well (and need paragraph makes this point on one type of solar). What is needed is an opportunity for the new technologies to emerge and some reasonable incentive for their use. [Michael MacCracken, United States of America]</td>
<td>Taken into account, this is discussed in II.4.3</td>
</tr>
<tr>
<td>5935</td>
<td>14</td>
<td>22</td>
<td>14</td>
<td>23</td>
<td>The phrase “economic feasible” may read “economically feasible” [Siyi KILKIS, Turkey]</td>
<td>Editorial</td>
</tr>
<tr>
<td>9989</td>
<td>14</td>
<td>23</td>
<td>14</td>
<td>25</td>
<td>Absolutely. Therefore notions of historic trends on technological path dependencies are false and should not be relied upon in designing scenarios and methodologies for 1.5 C transition. [Vania POPOVSTOVA, France]</td>
<td>Edited and taken into account</td>
</tr>
<tr>
<td>1291</td>
<td>14</td>
<td>29</td>
<td>14</td>
<td>30</td>
<td>The implications (principally economic and societal) of stranded assets should be mentioned in at least one additional sentence. [Colin Raymond, United States of America]</td>
<td>Accepted, included now</td>
</tr>
<tr>
<td>7799</td>
<td>14</td>
<td>29</td>
<td>14</td>
<td>30</td>
<td>Stranded assets can be technical assets (like power plants, oilfields and wells, or refineries) and fuels. Carbon Tracker has published extensive analyses of stranded assets across the range of hydrocarbons, lately including coal. [Amory Lovins, United States of America]</td>
<td>Accepted and noted</td>
</tr>
<tr>
<td>7904</td>
<td>14</td>
<td>29</td>
<td>14</td>
<td>30</td>
<td>Stranded assets can be technical assets (like power plants, oilfields and wells, or refineries) and fuels. Carbon Tracker has published extensive analyses of stranded assets across the range of hydrocarbons, lately including coal. [Amory Lovins, United States of America]</td>
<td>Taken into account</td>
</tr>
<tr>
<td>7923</td>
<td>14</td>
<td>29</td>
<td>14</td>
<td>30</td>
<td>Stranded assets can be technical assets (like power plants, oilfields and wells, or refineries) and fuels. Carbon Tracker has published extensive analyses of stranded assets across the range of hydrocarbons, lately including coal. [Amory Lovins, United States of America]</td>
<td>Accepted and noted</td>
</tr>
<tr>
<td>7958</td>
<td>14</td>
<td>29</td>
<td>14</td>
<td>30</td>
<td>Stranded assets can be technical assets (like power plants, oilfields and wells, or refineries) and fuels. Carbon Tracker has published extensive analyses of stranded assets across the range of hydrocarbons, lately including coal. [Amory Lovins, United States of America]</td>
<td>Taken into account</td>
</tr>
<tr>
<td>7963</td>
<td>14</td>
<td>29</td>
<td>14</td>
<td>31</td>
<td>Syriac incurred, meaning unclear [Amory Lovins, United States of America]</td>
<td>Editorial</td>
</tr>
<tr>
<td>7927</td>
<td>14</td>
<td>29</td>
<td>14</td>
<td>31</td>
<td>Syriac incurred, meaning unclear [Amory Lovins, United States of America]</td>
<td>Editorial</td>
</tr>
<tr>
<td>15407</td>
<td>14</td>
<td>29</td>
<td>14</td>
<td>30</td>
<td>Given that the climate change issue has been getting extensive discussion since the 1992 Earth Summit and Kyoto Agreement, it is time to stop calling much of the fossil fuel infrastructure ‘stranded assets’ and start calling it what it is, namely ‘bad investments’ or even, given that the fossil fuel companies mechanisms the science and opposed policy changes that would have allowed a slower pace of change, ‘irrationality derived investment’—those who have such investments should well have (and likely did) know better but did it anyway, and for that they deserve no sympathy. So, I would urge use of another phrase for such investments—it is not as if such investments are guaranteed as it provided for bank deposits, etc. (at least in some countries). [Michael MacCracken, United States of America]</td>
<td>Rejected, this would be a normative intervention that is not backed up in the scientific literature</td>
</tr>
<tr>
<td>4817</td>
<td>14</td>
<td>30</td>
<td>14</td>
<td>31</td>
<td>It is important to mention also that new investment in assets that will soon become stranded should be avoided. Accordingly, after the end of current paragraph... [Breyer 2017], new investment in further assets that would soon become stranded is economically damaging to the investor and expensive to be compensated by policymakers, so before such investment a full study of future remuneration and amortisation should be carried out leading, in many cases, to cancellation. [Valentino Piana, Italy]</td>
<td>Taken into account, but not necessary to add</td>
</tr>
<tr>
<td>3616</td>
<td>14</td>
<td>33</td>
<td>14</td>
<td>34</td>
<td>Some reference to separate 'social innovation' literature would be helpful here [Sevdar Tek, Canada]</td>
<td>Accepted, added</td>
</tr>
<tr>
<td>14246</td>
<td>14</td>
<td>34</td>
<td>14</td>
<td>35</td>
<td>The idea of technological transitions has been advanced by economists such as Schumpeter and Kondratief who talked about industrial change occurring in waves (Smith 2000; Adams and Mistry 2010). Are these historical economists? It's strange to not be citing their work but someone else talking about them? When did they talk about this? [Jose Antonio Puppim de Oliveira, Brazil]</td>
<td>Taken into account, references are included on Schumpeter and Kondratief. So original citation not needed</td>
</tr>
<tr>
<td>4818</td>
<td>14</td>
<td>42</td>
<td>14</td>
<td>42</td>
<td>The quoted Kemp et al. 1996a, a seminal paper, is pretty old and does not relate to climate change (it does not even mention it). A more recent piece of literature, directly relating to mitigation of climate change is Caniels, M.C.J. and H.A. Romijn (2009), 'Strategic Niche Management as a Policy Instrument for Climate Change Mitigation', in: V. Piana (Ed.), Innovative Economic Policies for Climate Change Mitigation. Economics Web Institute: Rome, Italy, 67-82.</td>
<td>Accepted, added</td>
</tr>
<tr>
<td>9337</td>
<td>14</td>
<td>43</td>
<td>14</td>
<td>44</td>
<td>The statement ‘functional approaches through technological innovation systems’ (Hekkert et al. 2007; Berecz et al. 2008) are applied in practice to develop policy responses to innovation challenges may be supported by additional references from the literature. These include the integration of the functional approaches literature and sustainability-oriented innovation systems. An example may be given as K7877, etc. (2016) Sustainability-oriented innovation system analyses of Brazil, Russia, India, China, South Africa, Turkey and Singapore. Journal of Cleaner Production Volume 130, 1 September 2016, Pages 235-247 <a href="https://doi.org/10.1016/j.jclepro.2016.03.180">https://doi.org/10.1016/j.jclepro.2016.03.180</a>. [Siyi KILKIS, Turkey]</td>
<td>Accepted, added</td>
</tr>
<tr>
<td>10551</td>
<td>14</td>
<td>47</td>
<td>15</td>
<td>5</td>
<td>The idea of decoupling does not work in the long term (see Daly, 1998; Jackson, 2009; Dale et al. 2016, etc.) both in theory and practice with the wave-like nature of Schumpeterian innovation regime. New investment in further assets that would soon become stranded is economically damaging to the investor and expensive to be compensated by policymakers, so before such investment a full study of future remuneration and amortisation should be carried out leading, in many cases, to cancellation. [Valentino Piana, Italy]</td>
<td>Taken into account, our assessment of the scientific literature uncovers decoupling is happening</td>
</tr>
<tr>
<td>1292</td>
<td>14</td>
<td>48</td>
<td>14</td>
<td>49</td>
<td>The term ‘range of peaple: is unnecessarily vague. [Colin Raymond, United States of America]</td>
<td>Taken into account, the sentence was removed</td>
</tr>
</tbody>
</table>

Do Not Quote, Cite, or Distribute Page 37 of 159
The financial system is a reflection of the economic system. No surprise it is not sensitive to long term needs, which require many radical changes in the energy sector.

Global emissions have decoupled over the past two years? [Wilfran Moufouma Okia, France] Taken into account, revised

Insert semicolon before "Newman (2017)" [Valentino Piana, Italy] editorial - not needed, this is start of new sentence

Allwright, United Kingdom (of Great Britain and Northern Ireland) [276x65] http://www.ftse.com/Analytics/FactSheets/temp/87ca7a99-f9a6-4760-97e4-b4098a1c4331.pdf [Jennifer Morgan, Netherlands]

and their volatility have been lower in every timeframe (3M, 6M, 12M, 3YR, 5YR) than the underlying full indices. These "ex-fossil" indices are not perfect but exclude 100-150 major fossil companies. Their returns have been higher than the corresponding full indices of thousands of companies. This reinforces decreases in energy consumption. [Beat Brunner, Switzerland]

Where the requirement for the uptake of specific technologies and low carbon pathways being the key focus, this becomes increasingly important. The multiplier effect can be substantially enhanced with this decoupling. [Jose Antonio Puppim de Oliveira, Brazil]

The decoupling of economic growth and prosperity accumulation from fossil fuel consumption is a more accurate phrase. [Yana POPKOSTOVA, France]

The idea of decoupling needs to be treated more carefully. It seems that the access to energy rather than fossil fuels is what drives wealth. The evidence of decoupling needs to include ideas like improvements in energy intensity (how much economic growth can be achieved for a given amount of primary energy or, in this context, carbon intensity (how much economic good can be achieved for a given amount of released carbon in an economy)). Jurisdictions like Orebro were historically able to decouple their wealth from fossil fuels by changing their energy portfolio to include significantly more nuclear power. Presumably, other jurisdictions will be able to drive decoupling through other primary energy substitutions whether it be solar, wind, hydro etc. If the idea of decoupling energy intensity has been improving with time for most countries, and this point should be understood as a more general point than what is taken from (von Weizäcker et al. 2014, Newman 2017) A number of countries have long gotten a significant fraction of their energy from hydropower (Canada, Brazil, Norway) to name a few. [Mark Leibovici, Canada]

This might be true for some developed economies, but major emitters have still not reached a stage where economic growth has decoupled from emission growth. [Harminpura Gupta, India]


This idea of decoupling needs to be treated more carefully. It seems that the access to energy rather than fossil fuels is what drives wealth. The evidence of decoupling needs to include ideas like improvements in energy intensity (how much economic growth can be achieved for a given amount of primary energy or, in this context, carbon intensity (how much economic good can be achieved for a given amount of released carbon in an economy)). Jurisdictions like Orebro were historically able to decouple their wealth from fossil fuels by changing their energy portfolio to include significantly more nuclear power. Presumably, other jurisdictions will be able to drive decoupling through other primary energy substitutions whether it be solar, wind, hydro etc. If the idea of decoupling energy intensity has been improving with time for most countries, and this point should be understood as a more general point than what is taken from (von Weizäcker et al. 2014, Newman 2017) A number of countries have long gotten a significant fraction of their energy from hydropower (Canada, Brazil, Norway) to name a few. [Mark Leibovici, Canada]

This might be true for some developed economies, but major emitters have still not reached a stage where economic growth has decoupled from emission growth. [Harminpura Gupta, India]

The relevance of disruptive innovation at city level is mentioned but not explained expanded (Seifert et al. 2013) [Seifert Pahwa Gajjar, India]

For the decoupling process to be accelerated and sustained, and the energy transformation (liberalized, an accelerated knowledge transfer needs to be achieved. The development and dissemination of tailored information campaigns, case studies and learning materials at local level has proven to achieve considerable results in terms of popular demand for action, bottom-up mandates for strong policy mechanisms and accelerated investment into low-carbon assets spurred by reputational and business benefits. [Yana POPKOSTOVA, France]

Accepted, accelerating response is discussed in 4.4.5 (now 4.4.3) including tailored information campaigns

The financial system is a reflection of the economic system. No surprise it is not sensitive to long term needs, which require many radical changes in the short term. [Jose Antonio Puppim de Oliveira, Brazil]

The decoupling of energy and economic growth is also due to the competitive advantage of efficiency, which has become the driving force, while the economy of scale has become an economy of platforms where energy efficiency (and thus energy efficiency services) has become a key competitive advantage. This reduces increases in energy consumption. [Beat Brunner, Switzerland]

Accepted, decoupling response is discussed in 4.4.5 (now 4.4.3) including tailored information campaigns

The financial system is a reflection of the economic system. No surprise it is not sensitive to long term needs, which require many radical changes in the short term. [Jose Antonio Puppim de Oliveira, Brazil]

The decoupling of energy and economic growth is also due to the competitive advantage of efficiency, which has become the driving force, while the economy of scale has become an economy of platforms where energy efficiency (and thus energy efficiency services) has become a key competitive advantage. This reduces increases in energy consumption. [Beat Brunner, Switzerland]

Accepted, decoupling response is discussed in 4.4.5 (now 4.4.3) including tailored information campaigns

The decoupling of energy and economic growth is also due to the competitive advantage of efficiency, which has become the driving force, while the economy of scale has become an economy of platforms where energy efficiency (and thus energy efficiency services) has become a key competitive advantage. This reduces increases in energy consumption. [Beat Brunner, Switzerland]

Accepted, decoupling response is discussed in 4.4.5 (now 4.4.3) including tailored information campaigns

The concept of decoupling economic growth from use of fossil fuels could be better explained. An example of how the economy can grow without increased use of fossil fuels should be given. For example, with increased service-oriented industries, the economy can grow without an increase in fossil fuels. Perhaps a similar argument can be made about the tech sector, if references are available. Also, rebound effects are mentioned but not described. The author should define what a rebound effect is and how it historically has affected this decoupling of fossil fuels and economic growth. I have only heard of the rebound effect being used in the context of energy efficiency as energy used is cut as devices are more efficient and then users tend to use more energy because their overall bills are down [Elizabeth Addon, United States of America]
The relatively short length of this section in my view underestimates the importance of the financial sector, with multiple players. Arguably, much of the information is not (yet) in the peer-reviewed literature. The Task-Force-Of-Financial-Related-Disclosures may be noted as an initiative to move the private sector including the financial sector in more sustainable directions. The EU has made climate risk assessment for pension funds mandatory (https://www.reuters.com/article/us-eu-finance-climate-change-eu-evp-companies-increasingly-take-into-account-environmental-social-and-governance-('ESG) criteria to enhance the sustainability and ethical impact of their investments (from a Social Corporate Responsibility point of view). The risks of climate impacts may also be lower than - 1.5 degrees - climate policy) for the stability of financial sector should also be noted, e.g., http://www.nature.com/nclimate/journal/v7/n9/full/nclimate3255.html?WT.feed_name=subjects_business&WT.feed_filter=related+to+Climate+change &+Energy+Transition [Rob Swart, Netherlands]

800 15 9 15 14

How can a 2008 reference be reliable in 2017? In 2008 nearly everyone assumed renewables would cost much more than fueled resources? I think we know they cost less. (NERL’s REPs study indicated slightly higher costs in 2010, but when a few years later, showed same-or-lower costs vs business-as-usual (BAU), and since then costs have fallen dramatically.) (Lovins & RM (2011), summarized by Lovins (2015, 2015a), showed in great detail that with US GDP growth 2010-50, practical and proven means deployed at historically reasonable costs would profitably achieve 3x energy efficiency, including ex-electricity efficiency by 2050, plus 5x renewables and 82-89% lower fossil CO2 emissions with 2.6x GDP, would save $5 trillion NPV in private internal cost. (So far, this trajectory is on track in the marketplace 2010-16.) Similarly, the Chinese government’s top energy agency (ERI 2017, Price et al. 2017, Zhou et al. 2016) showed that 2010-50 Chinese 7x energy productivity, 13x carbon productivity, 67% shift off fossil fuels (92% in the power sector), 80% of CO2, and 42% CO2 reduction (despite 7x GDP growth) would save $3.1 trillion NPV in private internal cost. (This uniquely detailed and rigorous study, reflecting >150 analyst-years’ effort by four leading organizations, was steered by the senior authors of the 13th Five Year Plan, which it strongly informed.) To be sure, the cashflow profile differs between these strong-efficiency-anti-renewables trajectories and BAU, but not only to-efficiency and must new resources have not only reduced capital intensity but also much shorter lead times and faster paybacks than marginal fossil-fuel systems, so their intensity-times-velocity capital requirements are generally even lower. And as it note in UK, modern energy efficiency using integrative design (in all sectors, Lovins 2010) typically exhibits not diminishing returns but expanding returns and declining capital intensity with scale (Lovins 2017). (Amory Lovins, United States of America)}

7005 15 9 15 14

How can a 2008 reference be reliable in 2017? In 2008 nearly everyone assumed renewables would cost much more than fueled resources? I think we know they cost less. (NERL’s REPs study indicated slightly higher costs in 2010, but when a few years later, showed same-or-lower costs vs business-as-usual (BAU), and since then costs have fallen dramatically.) (Lovins & RM (2011), summarized by Lovins (2015, 2015a), showed in great detail that with US GDP growth 2010-50, practical and proven means deployed at historically reasonable costs would profitably achieve 3x energy efficiency, including ex-electricity efficiency by 2050, plus 5x renewables and 82-89% lower fossil CO2 emissions with 2.6x GDP, would save $5 trillion NPV in private internal cost. (So far, this trajectory is on track in the marketplace 2010-16.) Similarly, the Chinese government’s top energy agency (ERI 2017, Price et al. 2017, Zhou et al. 2016) showed that 2010-50 Chinese 7x energy productivity, 13x carbon productivity, 67% shift off fossil fuels (92% in the power sector), 80% of CO2, and 42% CO2 reduction (despite 7x GDP growth) would save $3.1 trillion NPV in private internal cost. (This uniquely detailed and rigorous study, reflecting >150 analyst-years’ effort by four leading organizations, was steered by the senior authors of the 13th Five Year Plan, which it strongly informed.) To be sure, the cashflow profile differs between these strong-efficiency-anti-renewables trajectories and BAU, but not only to-efficiency and must new resources have not only reduced capital intensity but also much shorter lead times and faster paybacks than marginal fossil-fuel systems, so their intensity-times-velocity capital requirements are generally even lower. And as it note in UK, modern energy efficiency using integrative design (in all sectors, Lovins 2010) typically exhibits not diminishing returns but expanding returns and declining capital intensity with scale (Lovins 2017). (Amory Lovins, United States of America)
### Comment No 7059

**From Page:** 15  **From Line:** 15  **To Page:** 15  **To Line:** 14

**Comment:** How can a 2008 reference be reliable in 2017? In 2008 nearly everyone assumed renewables would cost much more than fueled resources if/when we knew they would succeed. (NERA’s REFs study indicated steeply higher costs in 2010, but only a few years later, showed same or lower costs vs. business-as-usual (BAU), and since then costs have fallen dramatically (Linnem & RM (2011), summarized by Linnem (2015, 2015a), showed in great detail that with 2050 GDP growth 2010-2050, practical and proven means deployed at historically low costs could profitably achieve 3x energy efficiency, including the electric efficiency by 2050, plus 5x renewables and 52-89% lower fossil CO2 emissions with 2x GDP, would save $5 trillion NPV in private internal cost. So far, this trajectory is on track in the marketplace 2010-18.) Similarly, the Chinese government’s top energy agency (ERI 2017, Zhao et al. 2016) showed that 2010-50 Chinese 7x energy productivity, 13x carbon productivity, 47% shift off fossil fuels (93% in the power sector, 87% off of coal), and 42% CO2 reduction (despite 7x GDP growth) would save $3.1 trillion NPV in private internal cost. (The unusually detailed and rigorous study, reflecting ~150 analysts-years’ effort by four leading organizations, was overseen by the senior authors of the 13th Five Year Plan, which strongly informs. To be sure, the cashflow profile differs between these strong-efficiency and renewables trajectories and BAU, but not only to efficiency and most renewables now have not only reduced capital intensity but also much shorter lead times and faster payback than marginal fossil-fueled systems, so their intensity-times-velocity capital requirements are generally even lower. And modern energy efficiency using integrative design (in all sectors, Linnem 2010) typically exhibits not diminishing returns but expanding returns and declining capital intensity with scale (Linnem 2017; [Avery et al., United States of America](#)).

**Response:** Taken into account, last is not no longer included - financial systems are discussed in Section 4.4.6

### Comment No 4021

**From Page:** 15  **From Line:** 15  **To Page:** 15  **To Line:** 9

**Comment:** Action in decarbonization of transport is very important for limiting warming to 1.5°, especially because other sectors may have exhausted their potential leverage already in 2C scenarios. Accordingly, the author should add transport to the list of investments. “As investment profiles of projects in energy, transport, land and urban system…” Please note that stock-exchange investors are already very positive on cutting-edge firms engaged the transition to a low-carbon system. For instance Tesla is currently blessed with a market capitalization similar or higher than GM and Ford exactly because the market believes, to some extent, that the Paris Agreement and global decarbonisation will lead the mainstream scenario of the evolution of the automotive sector. (Valentino Piana, Italy)

**Response:** Taken into account, last is not no longer included - financial systems are discussed in Section 4.4.6

### Comment No 14248

**From Page:** 15  **From Line:** 12  **To Page:** 15  **To Line:** 12

**Comment:** For renewable energy options such as wind and solar, investments are frontloaded and operational costs are relatively small, and also for energy efficiency, large investments need to be made early on, and the revenues as generated later. “This focus on solar and wind is inappropriate. The same statement can be made for hydro, geothermal, tidal and even nuclear power. In general, one of the biggest shining factors in fossil fuel use is that they’re quite cheap to set up, and even fairly cheap to run, but the external costs of their pollution (CO2 and otherwise) is what always causes problems for fossil fuels. This paragraph would support the following paragraph more strongly if the general nature of this problem were explored in more depth. [Avery, Ontario, Canada]

**Response:** Taken into account, last is not no longer included - financial systems are discussed in Section 4.4.6

### Comment No 4020

**From Page:** 15  **From Line:** 15  **To Page:** 15  **To Line:** 14

**Comment:** It is very common in all investments that large expenditures are at the beginning and revenues are generated later. This is not a surprise for the financial system. Renewable have a considerable advantage in time-to-build with respect to coal and nuclear plants. Accordingly, the author should integrate the sentence “… also for energy efficiency, large investments need to be made early on, and the revenues are generated later,” into something like “… also for energy efficiency, large investments need to be made early on, and the revenues are generated later. This is a reflection on the nature of the time value of money, its long-term perspective on revenue, and the development of value.” (Valentino Piana, Italy)

**Response:** Taken into account, last is not no longer included - financial systems are discussed in Section 4.4.6

### Comment No 10249

**From Page:** 15  **From Line:** 16  **To Page:** 15  **To Line:** 25

**Comment:** This paragraph could have been expanded to include e.g. without investing that has been around for the last decade. [Dufort Zimka, United Kingdom (of Great Britain and Northern Ireland)]

**Response:** Taken into account, last is not no longer included - financial systems are discussed in Section 4.4.6

### Comment No 18705

**From Page:** 15  **From Line:** 17  **To Page:** 15  **To Line:** 17

**Comment:** Starting to warm up to climate change mitigation - strange wording [Wilfran Moufouma Okia, France]

**Response:** Taken into account, last is not no longer included - financial systems are discussed in Section 4.4.6

### Comment No 1742

**From Page:** 15  **From Line:** 17  **To Page:** 15  **To Line:** 18

**Comment:** Suggest rephrasing to clarify meaning - is there some assessment here of the actual financial returns, relative to what is needed? [Penny Urquhart, South Africa]

**Response:** Taken into account; we give such orders of magnitude in section 4.4.8. we will likely give them in the SOD

### Comment No 4882

**From Page:** 15  **From Line:** 18  **To Page:** 15  **To Line:** 18

**Comment:** It is pretty amazing that no literature is quoted in reference to the pivotal Green Climate Fund, whose central role in the international response to climate change has been entangled in the UNFCCC negotiations and outcomes. A separate sentence, at least, should be devoted to the GCF, short of detailing it and possibly indicating venues for “strengthening” its crucial piece of the international response (focus of this chapter).

**Response:** Accepted, a reference to the role of the GCF should indeed be added here however, note that we can only quote peer-reviewed literature

### Comment No 4895

**From Page:** 15  **From Line:** 15  **To Page:** 15  **To Line:** 20

**Comment:** It would be necessary to mention the commitment of mobilising at least 10 billion dollars a year taken by the developed countries with the Copenhagen Accord and subsequent Cancun and Paris pledges. In response to the request of the developing countries, the developed countries produced this Roadmap to US100 billion. http://ldfb.gov.us/international_relations/themes/climate-change/Documents/climate-finance-roadmap-to-us100-billion.pdf

**Response:** Taken into account. This discussion has to be referred to because there is a large controversy between developed and developing countries about the additionality of the items of the roadmap. There is however the difficulty that this discussion is not conducted in peer-reviewed literature

### Comment No 11144

**From Page:** 15  **From Line:** 15  **To Page:** 15  **To Line:** 24

**Comment:** The sentence refers to pension funds facing challenges when electing to invest in climate-friendly activities. The authors refer to “Sovereigns 2013,” and “Maghi 2011.” In it all the case? A lot has changed in this area and the sources are really old keeping in mind the rate of change in this area [Michel Schaeffer, Netherlands]

**Response:** Taken into account, last is not no longer included - financial systems are discussed in Section 4.4.6
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>5218</td>
<td>15</td>
<td>23</td>
<td>15</td>
<td>25</td>
<td>The literature suggests that potential could still be materialized by engagement of the financial sector, but that this depends on political signals that affect the bankability of climate-friendly investments. In fact, there is no literature at all to support this. The reason is straightforward: from the perspective of at least one company, because in direct conversations with large institutional investors, this company has had responses and actions from the investors that showed the portfolio managers have funds with no action based on any long term climate change risks. While it is true that there are analysts, even in house analysts, whose expertise is in providing advice about the climate change activities and policies of governments and industry, the fact remains at this point that the portfolio managers when asked do not yet make any holding or investment decisions based on the potential long term effects from climate change. [Arthur Lee, United States of America]</td>
</tr>
<tr>
<td>4522</td>
<td>15</td>
<td>23</td>
<td>15</td>
<td>25</td>
<td>Examples of large-scale engagement of the financial sector can be found in the NABEO portal at UNFCCC (<a href="http://naboeco.unfccc.int/naboeco">http://naboeco.unfccc.int/naboeco</a>) and in many news releases and policies. This sentiment might then become: &quot;The literature suggests that potential could still be materialized by engagement of the financial system (e.g. by initiatives such as those highlighted at UNFCCC Climate action portal), but that this...&quot; [Valentino Piana, Italy]</td>
</tr>
<tr>
<td>10516</td>
<td>15</td>
<td>25</td>
<td>16</td>
<td>26</td>
<td>and also depends on clear governmental policies, as well as clear commitments from large customers, as well as general policy makers. Clear communication on fossil fuels phase out strategies could help immensely in redirecting large energy-related investments from fossil-fuels to clean renewable energy. Due to the hysteresis effect on the investment sector, changes like climate catastrophes could potentially quickly change the investment mood, and make clear that fossil fuels-related investments (in fuels and ICE engines in particular) are very risky investments, while renewable-energy ones are much safer. [Beat Brunner, Switzerland]</td>
</tr>
<tr>
<td>9990</td>
<td>15</td>
<td>25</td>
<td>15</td>
<td>27</td>
<td>This is not factually true. There are myriad of initiatives by public financial institutions, pension funds and insurance companies which dispense such a claim. Private groups are increasingly willing too divest from high-carbon assets and build coalitions around the commitment to provide financial armor to the transition movement. As such coalitions manifest themselves, this makes both commercial sense, avoids stranded assets and brings important reputation and branding benefits. One such action is the recently formed group &quot;Financing for tomorrow&quot; at <a href="http://www.financingfortomorrow.com">www.financingfortomorrow.com</a> which can provide important arguments for the authors to examine and see that not the political signal seems to not influence qualitatively the financial engagement with the energy transformation. [Yana POPKOVSKOVA, France]</td>
</tr>
<tr>
<td>11043</td>
<td>15</td>
<td>28</td>
<td>16</td>
<td>26</td>
<td>Unclear why &quot;organisations&quot; are excluded from the analysis here, since they matter very much in climate governance. See, for example, March of Resilience (2014 institutional inertia and climate change: a review of the new institutional change literature). Furthermore, &quot;political leadership&quot; is also requested on a national level, see Wibe 2017 (How Members of Parliament understand and respond to climate change) [Other Geden, Germany]</td>
</tr>
<tr>
<td>6303</td>
<td>15</td>
<td>26</td>
<td>16</td>
<td>27</td>
<td>The institutional and political dynamics here are crucial to understanding both the challenge of 1.5°C and the dynamics of the transition. But there is little in the passage that is really connected specifically to the institutional aspects of 1.5°C specifically - it is rather more generic about specific institutions (citizens) involved in some very specific findings (and not enormously insightful, as in the one that explicitly environmental committed legislators produce better environmental legislation). [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)]</td>
</tr>
<tr>
<td>10555</td>
<td>15</td>
<td>26</td>
<td>16</td>
<td>27</td>
<td>This section is important but brief and not well developed. Institutions are not just the &quot;rules of the game&quot; of the NIE definition of North. Also, The urbanization has been a factor of inrowing-emissions and not reducing it. Urbanization rates are more correlated to CO2 emissions than GDP per capa (see Stahl, M. and Poppim de Oliveira, Jose A. 2010) (from global 'North-South' to local &quot;Urban-Rural&quot;: A shifting paradigm in climate change. [Arthur Lee, United States of America]</td>
</tr>
<tr>
<td>18706</td>
<td>15</td>
<td>29</td>
<td>15</td>
<td>33</td>
<td>Wording grammatically incorrect [William Moufouda, Oka France]</td>
</tr>
<tr>
<td>19072</td>
<td>15</td>
<td>31</td>
<td>14</td>
<td>33</td>
<td>“...” and batteau emerge from socio-technical contexts made of specific material arrangements, competences and associated meanings (Shove 2010). This can be an oversimplified assumption. Behaviours emerge as result of a complex relationship dealing with specific material, political, economic, historic, geographic and cultural factors. [Beat Brunner, Switzerland]</td>
</tr>
<tr>
<td>14075</td>
<td>15</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td>Missing a comma after &quot;thens&quot;? [Elvira Poloczanska, Germany]</td>
</tr>
<tr>
<td>14122</td>
<td>15</td>
<td>32</td>
<td>39</td>
<td>39</td>
<td>all the back, avoid jargon [Elvira Poloczanska, Germany]</td>
</tr>
</tbody>
</table>

Accepted, but text is no longer included - financial systems are discussed in Section 4.4.6.
The leadership that is placed on cities to "bend the curve" by the year 2050 may be provided based on a recent report "Flexible 2020: How cities will get the job done" by the C40 Cities. The report analyses the contribution C40 cities can make to delivering the Paris Agreement objective of limiting global temperature rise to 1.5 degrees. Scenarios for peaking based on high/low GDP and high/low CO2 emissions per capita were also considered for such climate mitigation targets. [Siir KILKIS, Turkey]


The degree of autonomy of city governments from national government plays a key role in building its institutional and financial capacity to follow a climate resilient development pathway. Metropolitan governments which, due to a top-down, centralised government structure, rely heavily on national frameworks and finances to manage their own cities or regions may continue to follow traditional development frameworks. It stands to reason that if climate change resilient development is a key priority for nation state, there is the likelihood that subnational governments would consider this in the metropolitan development plans. [Valentino Piana, Italy]

Before talking about the sub-national level, a paragraph devoted to national level policy making and leadership is necessary. The Paris Agreement relies on Nationally Determined Contributions, so the level of leadership is the foundation of the international response to climate change. A sentence partially reflecting this insight would be "National level policy making is crucial to the success of the Paris Agreement, which relies on Nationally Determined Contributions, making this level the foundation of the international response to climate change. Many countries have not only produced, in a consultative and responsive process, ambitious NDCs but have institutionalised the response to climate change at cross-ministerial and ministerial levels. An indicator of strengthened engagement of the political leadership is the number and quality of new laws, strategies, and measures taken for mitigation and adaptation after the Paris Agreement entry into force." [Valentino Piana, Italy]

The Chinese government’s top energy agency (ERI 2017, Price et al. 2017, Zhou et al. 2016) showed that 2010–50 Chinese 7x energy productivity, 13x carbon productivity, 67% shift off fossil fuels (83% in the power sector), 80% off coal, and 42% CO2 reduction (despite 7x GDP growth) could save $3.1 trillion NPV in private internal cost. (This uniquely detailed and rigorous study, reflecting >150 analyst-years’ effort by four leading organizations, was steered by the senior authors of the 13th Five Year Plan, which it strongly informed.) [Amory Lovins, United States of America]

Who is or was a particular country subjected to, or mentioned (and please) under the general heading of “institutional and political leadership”? Political science is difficult to see the scientific justification for this as numerous other examples could have been given. Also, the reference for this is a comment piece (not an article or letter) in Nature. [Steffen Kallbekken, Norway]

Updating Bai et al. (2014) and repeating from lines 9–14 on this page: The Chinese government’s top energy agency (ERI 2017, Price et al. 2017, Zhou et al. 2016) showed that 2010–50 Chinese 7x energy productivity, 13x carbon productivity, 67% shift off fossil fuels (83% in the power sector), 80% off coal, and 42% CO2 reduction (despite 7x GDP growth) could save $3.1 trillion NPV in private internal cost. (This uniquely detailed and rigorous study, reflecting >150 analyst-years’ effort by four leading organizations, was steered by the senior authors of the 13th Five Year Plan, which it strongly informed.) [Amory Lovins, United States of America]

Updating Bai et al. (2014) and repeating from lines 9–14 on this page: The Chinese government’s top energy agency (ERI 2017, Price et al. 2017, Zhou et al. 2016) showed that 2010–50 Chinese 7x energy productivity, 13x carbon productivity, 67% shift off fossil fuels (83% in the power sector), 80% off coal, and 42% CO2 reduction (despite 7x GDP growth) could save $3.1 trillion NPV in private internal cost. (This uniquely detailed and rigorous study, reflecting >150 analyst-years’ effort by four leading organizations, was steered by the senior authors of the 13th Five Year Plan, which it strongly informed.) [Amory Lovins, United States of America]

Updating Bai et al. (2014) and repeating from lines 9–14 on this page: The Chinese government’s top energy agency (ERI 2017, Price et al. 2017, Zhou et al. 2016) showed that 2010–50 Chinese 7x energy productivity, 13x carbon productivity, 67% shift off fossil fuels (83% in the power sector), 80% off coal, and 42% CO2 reduction (despite 7x GDP growth) could save $3.1 trillion NPV in private internal cost. (This uniquely detailed and rigorous study, reflecting >150 analyst-years’ effort by four leading organizations, was steered by the senior authors of the 13th Five Year Plan, which it strongly informed.) [Amory Lovins, United States of America]

This is factually untrue. The current government initiatives and investment in low-carbon transition and technologies in China is spurred to a large extent by the way and to an extent of the public awareness and demands for better welfare. Chinese population demands to breathe cleaner air and the party desires. This is potentially one of the key areas of transformation in dominant party-population relationship in the country and is a very potent signal to the transformation of the society there. [Yana POPKOSTOVA, France]

This is factually untrue. The current government initiatives and investment in low-carbon transition and technologies in China is spurred to a large extent by the way and to an extent of the public awareness and demands for better welfare. Chinese population demands to breathe cleaner air and the party desires. This is potentially one of the key areas of transformation in dominant party-population relationship in the country and is a very potent signal to the transformation of the society there. [Yana POPKOSTOVA, France]

This is factually untrue. The current government initiatives and investment in low-carbon transition and technologies in China is spurred to a large extent by the way and to an extent of the public awareness and demands for better welfare. Chinese population demands to breathe cleaner air and the party desires. This is potentially one of the key areas of transformation in dominant party-population relationship in the country and is a very potent signal to the transformation of the society there. [Yana POPKOSTOVA, France]

This is factually untrue. The current government initiatives and investment in low-carbon transition and technologies in China is spurred to a large extent by the way and to an extent of the public awareness and demands for better welfare. Chinese population demands to breathe cleaner air and the party desires. This is potentially one of the key areas of transformation in dominant party-population relationship in the country and is a very potent signal to the transformation of the society there. [Yana POPKOSTOVA, France]
## Comment and Response

<table>
<thead>
<tr>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>It remains to be seen whether decoupling of emissions and growth in China (Newman 2017) can be sustained. In African countries, the case for climate resilient growth has been slow to gain political traction, in part because it requires perceived adjustment costs in the short term, in expectation of future gains (Reani et al. 2012). This may be changing since the Paris Agreement where developing 1 countries view climate resilient 2 economy as offering new competitive advantage (Carling 2015). This assessment is the critical assessment in this entire chapter. While China's combined and sustained growth of renewable energy and drive to reduce emissions, there will be no decoupling of emissions from economic growth. African nations have the largest potential to growth, yet case studies of successful and long-standing institutions to spur such growth are few and far between. Arthur Lee, United States of America</td>
<td>Taken into account, we removed section 4.2.3, Governance is now discussed in 4.4.1.</td>
</tr>
<tr>
<td>What is climate resilient growth here? The cited paper talks about green growth. Is this what the same? Clear definitions and/or referencing with 155-159 should help here. [Petroch Tschackal, Austria]</td>
<td>Taken into account, we removed section 4.2.3, Governance is now discussed in 4.4.1.</td>
</tr>
<tr>
<td>It would be important to mention the 48 COP Climate Liability Forum countries. Merrakesh Communique which says that these countries (with over a billion people) will 100% RE commitment! “Strive to meet 100% domestic renewable energy production as rapidly as possible”. They include countries from Africa, Asia, South America, Oceania etc! <a href="https://unfccc.int/files/meetings/marrakech_nov_2016/application/pdf/cvf_declaration_release_en.pdf">Hurtado, Steven P.</a> [Jennifer Morgan, United Kingdom]</td>
<td>Taken into account, we removed section 4.2.3, Governance is now discussed in 4.4.1.</td>
</tr>
<tr>
<td>These lines are the appropriate place where to add a significant sentence on SIDS / AOSIS countries, which requested this Special Report but are part of the world may require in the coming decade, through global response. [Sumetee Pahwa Gajjar, India]</td>
<td>Taken into account, this is discussed in 4.4.5 of FOD. The reference is included here. We now integrated this section into the section on enabling behaviour and lifestyle change.</td>
</tr>
<tr>
<td>The section 4.2.3 would benefit greatly with the addition of relevant social psychological literature. See as a starting point. Dayton et al. (2015) Psychological research and global climate change. Nature Climate Change, 5, 540-546 [Petroch Tschackal, Australia]</td>
<td>Taken into account, this is discussed in 4.4.5 of FOD. The reference is included here. We now integrated this section into the section on enabling behaviour and lifestyle change.</td>
</tr>
<tr>
<td>Section 4.3. As part of the feasibility assessments (or in addition to), each mitigation option should include the impacts (synergies and trade-offs) for adaptation and vice versa. [Debora Ley, Guatemala]</td>
<td>Accepted. Synergies and trade offs will be assessed.</td>
</tr>
<tr>
<td>Section 4.3. Within each of the sub-sections, there needs to be a clearer organization between mitigation and adaptation options. [Debora Ley, Guatemala]</td>
<td>Accepted. We will look at all the subsection titles and make sure all of them are indeed options.</td>
</tr>
<tr>
<td>Section 4.4. Additional adaptation options need to be included (from AR5, and Ch. 3) and included in the feasibility assessments. [Debora Ley, Guatemala]</td>
<td>Partially accepted. Additional options will be included in the SOD in the literature if and when chapter 3 includes them. However, we are not going to repeat the assessment in AR5.</td>
</tr>
<tr>
<td>This section 4.2.4 may need to be updated. As we move towards 2030-2040, the Paris Agreement is becoming more and more relevant as a framework for climate action. [Penny Urquhart, South Africa]</td>
<td>Taken into account, this is discussed in 4.4.5 of FOD. We now integrated this section into the section on enabling behaviour and lifestyle change.</td>
</tr>
<tr>
<td>There are also other sources of knowledge in Psychology that can support implementation of all the changes that need to occur to keep within the 1.5 C. Although guidelines by health care professionals). Psychology can contribute with key knowledge on behaviour change theories (many of which rely on key interactions between the person and its context and acknowledge that humans are not rational decision making machines) in order to allow the development of behavioral goals, action plans and coping plans. [Shinners et al 2005] This can target the actual mechanisms associated with behaviour enactment (e.g. taking the bike vs taking the car). There are currently multiple SR within the area of changing health behaviours that can be useful when thinking of changing individuals behaviour (e.g. around energy use at home, around recycling, around consumers, around transport choice). My team has published a SR that aimed at understanding what behaviour change techniques are better placed to support change to more sustainable (and healthy in some cases) transport modes (paper title: Efficacy of behavioral interventions for transport behaviour change. Systematic review, meta-analysis and intervention costing. Article link:<a href="https://doi.org/10.1186/1479-5868-11-132">International Journal of Behavior Nutrition and Physical Activity 11(1):132 - November 2014</a>. There are also other sources of knowledge in Psychology that can support implementation of all the changes that need to occur to keep within the 1.5 C. For instance, evidence on discrimination and collaboration in groups and group work; evidence on group composition and functioning; evidence on evidence on decision making (individual and in groups); evidence on stereotyping and overcoming stereotyping; evidence on diversity; evidence on status and power; evidence on mediation and conflict resolution; evidence on evidence on ownership; and implementation; evidence on evidence on leadership styles and how to support leadership development; evidence on how to engage in knowledge translation; evidence on how to engage in knowledge translation; evidence on the crucial role of creating policy and developing interventions to create environmental change (see also the work of Dr. Mrs Hemmati, Senior Associate at the MST Institute in Berlin, Germany and the work conducted with 140-150 municipalities in Germany as a case study). [Yasa Barbara Anjou Scubas Shnajhal, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Taken into account, this is discussed in 4.4.5 of FOD. We now integrated this section into the section on enabling behaviour and lifestyle change.</td>
</tr>
<tr>
<td>Indeed, I would appreciate a recap on what has happened in this year after Paris agreement, with respect to the steps that the different MSs have followed to actually implement what they have agreed on. Even a list of best-practises could be motivating for the governments of the different MS on climate change leadership in sustainable development. [Elda Mata, Sweden]</td>
<td>Rejected not relevant for this section.</td>
</tr>
<tr>
<td>Paris Agreement reference is not clear and implies an incorrect bifurcation with developing countries in the PA context. Farhan Akhtar, United States of America</td>
<td>Taken into account, we removed section 4.2.3, Governance is now discussed in 4.4.1.</td>
</tr>
<tr>
<td>The reference that climate resilient economies may be viewed as having competitive advantage (Czarnitzki et al. “The role of urbanisation and development which shall take place in Africa over the next 15 years is predicted by global think tanks to surpass previous levels, and contribute immensely to future emissions from the continent. Africa is a continent in which many Africa is covered in the chapter, does not capture the scale of attention this part of the world may require in the coming decade, through global responses. [Sumanmaya Paveja Gagar, India]</td>
<td>Taken into account, we removed section 4.2.3, Governance is now discussed in 4.4.1.</td>
</tr>
<tr>
<td>These lines are the appropriate place where to add a significant sentence on SIDS / AOSIS countries, which requested this Special Report but are currently barely mentioned in this chapter. You may quote here their efforts in adaptation and financial needs, together with the fact that in such countries, climate change is a major political priority, often with a climate ministry or unit directly reporting to the Prime minister. [Valentino Plana, Italy]</td>
<td>Taken into account - covered in section 4.4.5 of FOD, The reference is included here. We now integrated this section into the section on enabling behaviour and lifestyle change.</td>
</tr>
<tr>
<td>Comment No</td>
<td>From Page</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>5903</td>
<td>16</td>
</tr>
<tr>
<td>5930</td>
<td>16</td>
</tr>
<tr>
<td>19717</td>
<td>16</td>
</tr>
<tr>
<td>20248</td>
<td>16</td>
</tr>
<tr>
<td>10852</td>
<td>16</td>
</tr>
<tr>
<td>11463</td>
<td>16</td>
</tr>
<tr>
<td>924</td>
<td>16</td>
</tr>
<tr>
<td>4793</td>
<td>16</td>
</tr>
<tr>
<td>7085</td>
<td>16</td>
</tr>
<tr>
<td>20625</td>
<td>16</td>
</tr>
<tr>
<td>15404</td>
<td>16</td>
</tr>
<tr>
<td>7096</td>
<td>16</td>
</tr>
<tr>
<td>7097</td>
<td>16</td>
</tr>
<tr>
<td>18707</td>
<td>16</td>
</tr>
<tr>
<td>6304</td>
<td>16</td>
</tr>
</tbody>
</table>

**Response**

- Accepted, factors influencing changes in sustainable lifestyles and behaviour are discussed in 4.4.3
- Accepted, changes into walk or cycle short distances, or use public transport rather than drive or fly - now included in 4.4.3
- Accepted, factors influencing changes in sustainable lifestyles and behaviour are discussed in 4.4.3
- Accepted, included now in 4.4.3
- Accepted, included now in 4.4.3
- Accepted, included now in 4.4.3
- Taken into account - text has been revised , with additional adaptation options included in the SOD, together with trade-offs and synergies with other options
- Taken into account - text has been revised - with additional adaptation options included in the SOD, together with trade-offs and synergies with other options
- Taken into account - text has been revised - with additional adaptation options included in the SOD, together with trade-offs and synergies with other options
- Taken into account - we included a key reference (Hackmann et al 2014), and refer to chapter 2 - please not that this section is now included in 4.4.3
- Taken into account - we included a key reference (Hackmann et al 2014), and refer to chapter 2 - please not that this section is now included in 4.4.3
- Taken into account - discussed in section 4.4.3. Effects of climate change on sustainable development indicators are discussed in chapter 5
By utilizing climate data and user energy consumption data, energy consumption forecast models can be developed to predict energy consumption in the coming weeks or even weather forecasts could be used. This allows timely energy-saving measures to be taken in response to early alerts of high energy consumption days under hot weather situations. Reference: 1. Cheng, E., S. Lee, S. Tsoi, T. C. Lee, W. K. Wang, J. Lai and C. Chan, 2016: The Meter Online Service - Application of weather information in support of CLP electricity consumption forecast for customers, presented in the CEP5S - Conference of the Electric Power Supply Industry, Bangkok, Thailand, 23-24 October 2016. [Sai Ming Lee, China]

Takken 2014 not added to manuscript [Wilfran Moufouma Okia, France]

Takken 2014 not added to manuscript [Wilfran Moufouma Okia, France]

Takken 2014 not added to manuscript [Wilfran Moufouma Okia, France]

Takken 2014 not added to manuscript [Wilfran Moufouma Okia, France]

Takken 2014 not added to manuscript [Wilfran Moufouma Okia, France]

Takken 2014 not added to manuscript [Wilfran Moufouma Okia, France]

Takken 2014 not added to manuscript [Wilfran Moufouma Okia, France]

Takken 2014 not added to manuscript [Wilfran Moufouma Okia, France]

Takken 2014 not added to manuscript [Wilfran Moufouma Okia, France]

Takken 2014 not added to manuscript [Wilfran Moufouma Okia, France]
We would suggest moving these lines up to the very beginning of section 4.2.3 Behavioural Change, in order to frame upfront behavioural change as it is a systemic change that requires several enabling factors, including infrastructure, policies and social norms and values. The most reputable and evidence-based behavioural change models reinforce this understanding (e.g. Michie, S. et al. (2014)). The behavioural change wheel. A guide to theory-driven intervention. Great Britain. 2014. Available from: http://www.behaviourchangewheel.org/online-book4/. The way section 4.2.3 has been drafted, it treats behaviour change as something belonging to the individual sphere and boiled down to individual actions, which is a perspective that considerably limits the actual potential of behavioural change to happen. If the sentence is currently at the end of the section is actually crucial for understanding and describing behaviour change, then the need to have it upfront is of a priori framing of the topic. [Mariene Nicioli, Germany]

Taken into account. The section discusses which types of behaviour will help limit global climate change, factors influencing such behavior and effects and acceptability of strategies to change behaviour are discussed in 4.4.5 of FOD. We now integrated this section in the section on small-scale behaviour and lifestyle change.

The Section title “Assessment of current and emerging (adaptation and mitigation) options” is a bit misleading considering CDR and SRM are also assessed. How about rephrasing it to something like “Assessment of current and emerging options (adaptation, mitigation, CDR and SRM)?” or “Assessment of current (adaptation, mitigation) and emerging (CDR and SRM) options”? [Melane Mut, Norway]

Partially accepted. Good suggestion to change the section title. However, the suggested revision does not work as we cannot consider CDR and SRM as not an option but a response. Section title will be changed instead to “Feasibility assessment” or “Feasibility assessment of mitigation and adaptation options and remedial measures”.

Taken into account. We will re-check the list against the list on the website given. Thank you, especially at district heating, bio-solids, Bio carbon – coalled wood, Methane digester, need to energy CCS, and many utilization in buildings with wood and biomass. As stated in the chapter, we don’t have space in this report to be comprehensive: we are assessing options that have significant new insights in the literature since AR5. Also, Drawdown may not be comprehensive; it is missing some of the CDR options.

Noted. This chapter is about assessing options, and the trade-offs and synergies between mitigation and adaptation options, thus, it needs to be integrated.

Noted. After discussion the Table was revised as some readers will only read Chapter 4 and the table is essential to Section 4.5. A third (mitigation) and fourth (adaptation) column has been added in Chapter 4.

Noted. This being considered by Chapter 1. Additional columns added to the table in Chapter 4 for the benefit of the feasibility study.

Noted. Outline of feasibility in Chapter 1 which are obliged to use in the framing here - emphasizes multiple dimensions of feasibility not just cost and benefit.

Accepted and text revised. The lines referred to are wrongly saying how feasibility was dealt with in the AR5. The definition developed in the SR builds on AR5 and takes feasibility beyond narrow economic dimensions by introducing multiple dimensions.

Noted. The framing of feasibility is done by Chapter 1 and the important emphasis on multiple dimensions of feasibility and differences across regions and contexts. This section is obliged to draw on that framing for assessing feasibility of climate responses.

Accepted and text revised. The lines referred to are wrongly saying how feasibility was dealt with in the AR5. The definition developed in the SR builds on AR5 and takes feasibility beyond narrow economic dimensions by introducing multiple dimensions.

Note "equity and justice" feature strongly in Chapter 5.

Accepted. Text amended to reflect the importance of distributional elements to both the process and the feasibility of the outcomes of 1.5C pathways. Two columns, "Social & regional inclusiveness" and "Intergenerational equity" have been added as parameters of feasibility used in Section 4.5. Note "equity and justice" feature strongly in Chapter 5.

Accepted. This section discusses which types of behaviour will help limit global climate change, factors influencing such behavior and effects and acceptability of strategies to change behaviour are discussed in 4.4.5 of FOD. We now integrated this section in the section on small-scale behaviour and lifestyle change.

Noted. AR5 had a section on “feasibility” on which this SR expands by describing the multiple dimensions of feasibility and differences across regions and contexts. This section is obliged to draw on that framing for assessing feasibility of climate responses.

Noted. The framing of feasibility is done by Chapter 1 and the important emphasis on multiple dimensions of feasibility and differences across regions and contexts. This section is obliged to draw on that framing for assessing feasibility of climate responses.

Noted. After discussion the Table was revised as some readers will only read Chapter 4 and the table is essential to Section 4.5. A third (mitigation) and fourth (adaptation) column has been added in Chapter 4.

Noted. This being considered by Chapter 1. Additional columns added to the table in Chapter 4 for the benefit of the feasibility study.

Noted. Outline of feasibility in Chapter 1 which are obliged to use in the framing here - emphasizes multiple dimensions of feasibility not just cost and benefit.

Accepted and text revised. The lines referred to are wrongly saying how feasibility was dealt with in the AR5. The definition developed in the SR builds on AR5 and takes feasibility beyond narrow economic dimensions by introducing multiple dimensions.

Accepted. Text amended to reflect the importance of distributional elements to both the process and the feasibility of the outcomes of 1.5C pathways. Two columns, "Social & regional inclusiveness" and "Intergenerational equity" have been added as parameters of feasibility used in Section 4.5. Note "equity and justice" feature strongly in Chapter 5.

Accepted. This section discusses which types of behaviour will help limit global climate change, factors influencing such behavior and effects and acceptability of strategies to change behaviour are discussed in 4.4.5 of FOD. We now integrated this section in the section on small-scale behaviour and lifestyle change.

Taken into account. The section discusses which types of behaviour will help limit global climate change, factors influencing such behavior and effects and acceptability of strategies to change behaviour are discussed in 4.4.5 of FOD. We now integrated this section in the section on small-scale behaviour and lifestyle change.
To react, people must feel concerned and empowered to face their issue. Lowering my CO2 benefits doesn’t give me immediate benefits, and additionally doesn’t give me the feeling that I alone solve the global warming issue by doing so. This leads to the actual situation of a “nudge and a feel” – an “in the crevice” – not just “in the corner”, where I can’t do anything about it feelings. Institutions and governments should emphasize the local and immediate benefits of decarbonization.

CO2 emissions (affecting global scale) are intimately linked to local pollution and lower comfort, compared to their electrified counterparts. People are much more concerned by their long-term health and immediate comfort than their CO2 emissions – where their immediate benefits are null. Local pollution includes health-affecting noise, particles, and toxins emitted by combustion and ICEs. All of this affects directly medium and long-term health of people mainly: locally.

- Confort includes much quieter roads, fresher air, better visibility and skyline in urban areas, less smell and irritations, more comfortable rides in vehicles, no stops at gas-stations, no discomfort in headings and their refuellings, the feeling to contribute to sustainability and progress.

Those immediate and local benefits to the persons or communities that participate to decarbonization are much easier to understand and to motivate people than long-term, beyond our lifetime year 2050 or 2100 goals. [Bosch Bruyn, Switzerland]

In Section 4.4, option for adaptation, mitigation and SRM... Should this rather be: “in Section 4.4.4, options for adaptation, mitigation, CDR and SRM...” [Kleiner Martin, Norway]


This list of measures is very short at the moment in the SR but I assume it will grow in the revised version with the extended literature rewrite [Erika Mata, Sweden]

What does “rate of land-use change” refer to?” [Michiel Schaeffer, Netherlands]

Recognising the multiple dimensions of feasibility becomes particularly important in the context of ‘negative emissions’ options such as BECCS, that are understood to be an important part of 1.5°C pathways - negative emissions are also needed for the majority of 2°C pathways, they are not just specific to 1.5 °C pathways. [Michiel Schaeffer, Netherlands]

Table 4.1 is a necessary feature” [Piers Forster, United Kingdom (of Great Britain and Northern Ireland)]

The use of “institutional” here seems somewhat inconsistent with the use of “institutional” in 4.2.3.5 [Oliver Geden, Germany]

No literature examples for ecosystems given (i.e. no citations) [Elvira Poloczanska, Germany]

No mention in the context of ‘negative emissions’ options such as BECCS, that are understood to be an important part of 1.5°C pathways - negative emissions are also needed for the majority of 2°C pathways, they are not just specific to 1.5 °C pathways. [Michiel Schaeffer, Netherlands]

Noted. The behavioural components of change are to be given more systemic attention in Section 4.4.4, but have been included in the added columns of Table 4.1 with criteria of “Public acceptance”, “Socio-cultural acceptability” and “Social & regional inclusiveness” [Oliver Geden, Germany]
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>11146</td>
<td>17</td>
<td>26</td>
<td>17</td>
<td>27</td>
<td>The need to categorize empirical measures by both “characteristics” and “diversity” seems unnecessary from looking at Table 4.1 - perhaps this could be explained further. [Michael Schaeffer, Netherlands]</td>
<td>Accepted. Empirical measures have been replaced by the parameters used in feasibility assessment Section 4.4. The final two columns of the table are adopted from Chapter 1.</td>
</tr>
<tr>
<td>11147</td>
<td>17</td>
<td>26</td>
<td>17</td>
<td>27</td>
<td>For technological characteristics, apart from the measures limits it would be good to mention the human resources. For some rapidly developing industries, e.g., the installation of the PV panels or maintenance of the wind turbines, there may be the issue of lacking qualified workforce. [Michael Schaeffer, Netherlands]</td>
<td>Accepted. Empirical measures have been replaced by the parameters used in feasibility assessment Section 4.4. These include a specific parameter around human capability and institutional capacity.</td>
</tr>
<tr>
<td>11148</td>
<td>17</td>
<td>26</td>
<td>17</td>
<td>27</td>
<td>For the social and cultural characteristics a clear reference to managing job losses in the energy intensive industries is lacking [Michael Schaeffer, Netherlands]</td>
<td>Accepted. New parameters added for adaptation and mitigation in this table include jobs, productivity and distributional impacts.</td>
</tr>
<tr>
<td>11149</td>
<td>17</td>
<td>26</td>
<td>17</td>
<td>27</td>
<td>For the institutional characteristics the “rate of institutional change” could be complemented by “and learning” institutions need to adapt and learn, which will lead to change but also determines the way these institutions change. [Michael Schaeffer, Netherlands]</td>
<td>Accepted, but not in Box. Reference to social learning now enhanced in sub-sections of 4.4.</td>
</tr>
<tr>
<td>12490</td>
<td>17</td>
<td>26</td>
<td>17</td>
<td>27</td>
<td>Table 4.1</td>
<td>- Can we really project technological learning curve? The unprecedented progress in digitalization and RES technologies over the past 5 years has disproved all previous attempts to factor in how quickly different types of technologies can be implemented.</td>
</tr>
<tr>
<td>7985</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td>Technical and economical problems are raised, never really quantified. The fact that “the financial literature is practically silent on climate change” may be a consequence of the non-economic-profitability of renewable energies in comparison to existing energy sources, in the absence of substantial subsidies. The lesson, which is not really discussed in the document, is that the present economical environment may not be compatible with the massive development of renewables, as emphasized in the document? [Jean Marie Seiler, France]</td>
<td>Noted. Evaluated in Chapter 4 (not Table 4.1) and a new section on “loss and damage” is being developed in Chapter 4. This cannot “preclude” a policy response, but has to be given in a higher profile in the text.</td>
</tr>
<tr>
<td>10210</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td>The section should point to flexibility box (Fare, Fondriest, United Kingdom (of Great Britain and Northern Ireland))</td>
<td>Accepted. Text revised.</td>
</tr>
<tr>
<td>10217</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td>Do Not Quote, Cite, or Distribute Page 48 of 159</td>
<td></td>
</tr>
<tr>
<td>7058</td>
<td>18</td>
<td>3</td>
<td>18</td>
<td>4</td>
<td>Do the authors plan to disclose important principles on a regional and national basis, if such a differentiation is required? My worry is that only rather evident guidelines are provided otherwise. [Érika Mata, Sweden]</td>
<td>Noted. This is a global assessment. While efforts have been made to include the importance of systems and enabling environments, and while case studies try to provide location specific examples, it has not been possible to provide regional specificity. Table 4.1 now includes two new columns of parameters that may provide some of the granularity required.</td>
</tr>
<tr>
<td>11150</td>
<td>18</td>
<td>5</td>
<td>18</td>
<td>5</td>
<td>The section refers to the SRM options as if these are an acceptable solution on par with mitigation and adaptation, whereas earlier, on page 7 (line 21-22) of the overview of SRM highlighted, SRM should be treated more cautiously (and not put on par with mitigation and adaptation - given the profoundly different global uncertainties are not ruled out in other chapters). [Michael Schaeffer, Netherlands]</td>
<td>Noted. Has been part of deliberations at LAM3. This is a feasibility assessment and SRM is one of the measures in the literature, we don’t assume anything but evaluate options in terms of criteria.</td>
</tr>
<tr>
<td>4796</td>
<td>18</td>
<td>6</td>
<td>18</td>
<td>9</td>
<td>Since for some (individuals and countries) climate change can be beneficial with disadvantages outweighed by the advantages, a classic technique to use the support of those interested in non-compliance should also be avoided: comparison for losses incurred by implementing or tolerating mitigation/adaptation policies; cf. David Gauthier, Moral by Agreement, Oxford UP 1996. (Markus Warsenburg, Netherlands)</td>
<td>Noted. This chapter was asked by the initial plenary to include a reference to existing rates of technological change (4.2-2) but the final draft emphasizes the need for and examples of systemic, non-linear change.</td>
</tr>
<tr>
<td>16409</td>
<td>18</td>
<td>10</td>
<td>18</td>
<td>11</td>
<td>Consistent with the need to get back to 0.5 C or lower, this should say “consistent with 1.5 C or lower and...” [Michael MacCracken, United States of America]</td>
<td>Noted. But not clear that this refers to Table 4.1.</td>
</tr>
<tr>
<td>19719</td>
<td>19</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>These non-climate benefits can also include benefits in terms of gender equality and diversity. See for example: Rights for Actipng People and the Centre of Action on Climate Change (Nov2015) Online at <a href="http://www.mrfr.org.uk/content/uploads/2015/11/MRFR2-Rights-for-Action-edition-2.pdf">http://www.mrfr.org.uk/content/uploads/2015/11/MRFR2-Rights-for-Action-edition-2.pdf</a></td>
<td>Noted. The point has now been included here and in 4.4.1. The citation has not been included but will be reviewed as grey literature.</td>
</tr>
<tr>
<td>2745</td>
<td>18</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>Could edit “in other words, climate resilient development” [Perry Linkhurst, South Africa]</td>
<td>Accepted. Text substantially revised and the sentence no longer stands.</td>
</tr>
<tr>
<td>4302</td>
<td>18</td>
<td>3</td>
<td>18</td>
<td>4</td>
<td>Example of the above it should be plainly obvious to state (without the need of so many references) that “there are many opportunities to align climate interventions with efforts that support livelihoods and local environment”. But the question remains quantifiable: are these “high priority”, “soft”, “green of sacrifice, interventions SUFICIENTLY to achieve the 1.5 C target? I am dismayed reading the whole 4.3.1 because so much unnecessary references comes with so many unnecessary references - HAYANBERD THE AUTHOR OF THIS INDEX CARLOS SPINT</td>
<td>Noted. This is a global assessment. While efforts have been made to include the importance of systems and enabling environments, and while case studies try to provide location specific examples, it has not been possible to provide regional specificity. Table 4.1 now includes two new columns of parameters that may provide some of the granularity required.</td>
</tr>
<tr>
<td>13401</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td>What is “climate intervention” here referring to? It’s a bit confusing, considering the National Academy of Sciences defined it as another label for climate geoengineering. I guess you are not exclusively referring to geoengineering. I therefore suggest you rephrase or define what you mean by the term. [Helene Muri, Norway]</td>
<td>Accepted. Reference will be removed here.</td>
</tr>
<tr>
<td>11059</td>
<td>18</td>
<td>18</td>
<td>25</td>
<td>27</td>
<td>I don’t see which evidence Peters et al. 2017 provide for this statement. I cannot tell for the other articles, since I just know the paper of Peters et al. quite well. This is not meant to criticize Peters et al. in general. The article is cited several times throughout in Chapter 4. From my point of view, it makes sense in some cases, but doesn’t in other cases (see below). [Jakob Wachsmuth, Germany]</td>
<td>Noted. Revision to text in the section and in section 4.4.1 on enabling environment.</td>
</tr>
<tr>
<td>10353</td>
<td>18</td>
<td>29</td>
<td>18</td>
<td>55</td>
<td>The flow of the text from feasibility into feasibility assessments, uncertainty in sub-optimal. While it is clear that the message is important, the ramifications on policy design could be made clearer. [Sumalee Pathak Gajar, India]</td>
<td>Accepted. Reference to existing rates of technological change (4.2-2) but the final draft emphasizes the need for and examples of systemic, non-linear change.</td>
</tr>
<tr>
<td>7094</td>
<td>18</td>
<td>42</td>
<td>18</td>
<td>47</td>
<td>What about the robustness of key parameters to uncertainty? Could it be good to identify clearly, e.g. that is good to reduce emissions full stop, or to insulate buildings full stop; whereas it may not be so smart to focus on only attaining cost-efficient opportunities (as profitability is per se an uncertain parameter). [Tara Shine, Ireland]</td>
<td>Accepted. Empirical measures have been replaced by the parameters used in feasibility assessment Section 4.4. These include a specific parameter around human capability and institutional capacity.</td>
</tr>
<tr>
<td>7334</td>
<td>18</td>
<td>42</td>
<td>18</td>
<td>47</td>
<td>A new section focusing the implications of the time frame of irreversible events or decision pathways. Wieringa and Parthen (2017): keeping long-term investments under uncertain and ongoing change. [Wim van Oldenburg.de/fileadmin/user_upload/lifestyle/growth/CSR/4.3-Paper-revised-17.pdf ; Jasper Meyns, Germany]</td>
<td>Accepted and changed to “avoiding “lock-in” as a planetary term in IRS and in this report.</td>
</tr>
<tr>
<td>19074</td>
<td>18</td>
<td>44</td>
<td>18</td>
<td>47</td>
<td>Change: UN-ACC - “uncertain” [Kristin Skone, USA, Germany]</td>
<td>Accepted. Have removed “difficult to predict” completely.</td>
</tr>
<tr>
<td>1913</td>
<td>18</td>
<td>45</td>
<td>18</td>
<td>47</td>
<td>Accepting the robustness of key parameters to uncertainty is the key to understanding what “climate change” is and will look like. [Miriam Solera Ureña, Germany]</td>
<td>Noted. This chapter was asked by the initial plenary to include a reference to existing rates of technological change (4.2-2) but the final draft emphasizes the need for and examples of systemic, non-linear change.</td>
</tr>
</tbody>
</table>

Table 4.1
- Can we really project technological learning curve? The unprecedented progress in digitalization and RES technologies over the past 5 years has disproved all previous attempts to factor in how quickly different types of technologies can be implemented. To subtract - economic - add - benefits of preventive proactive investment as compared to reactive investment (once a climate-related hazard has occurred, sea-level lines have been destroyed, people have migrated due to climate-related push factors, etc.) [Vanya POPROSTOVA, France]
Suggested to simplify the language of this sentence. [Elvira Poloczanska, Germany]

The systemic approach implicit in this characterisation of feasibility introduces analytical complexity to the need for prioritisation (Reyers et al. 2017).

Acceptance and text amended. "The systemic approach implicit in this characterisation of feasibility introduces analytical complexity to the need for prioritisation (Reyers et al. 2017)."

Chapter 1 and 2 deal with overshoot and a cross chapter box deals with the 1.5 definitions.

Nominated. Chapters 1 and 2 deal with overshoot and a cross chapter box deals with the 1.5 definitions.

Do the authors plan to present examples of such multicriteria analysis? [Erika Maria, Sweden]

Nominated. An MCA is developed in 4.5 of this Chapter in SOD. The references refer to examples that have been used to compile this. See expanded Table in this section which includes the making of columns.

Which "guidelines considerations"? [Rob Swart, Netherlands]

Accepted. Text amended to refer to elements of feasibility developed in Chapter 1. We have worked closely with Chapter 1 to provide a new table for this section, and have included new columns in this table to reflect the approach taken to feasibility in Section 4.5.

Do the authors plan to present exemples of such multicriteria analyses? [Erika Maria, Sweden]

Accept - section has been revised

How do you intend to address this concern? [Abanades Carlos, Spain]

Accept - whole section revised

Hydropower and Bio-energy are very wide terms (used in other sections too), these should be referenced as large-scale hydro and micro-hydro, also any mention of bio-fuels should differentiate between the use of 1st generation (agricultural product), 2nd generation (waste derived) and 3rd generation (algae or other chemical synthesis) production - the former being in general viewed as the least sustainable option.

Any mention of bio-fuels should differentiate between the use of 1st generation (agricultural product), 2nd generation (waste derived) and 3rd generation (algae or other chemical synthesis) production - the former being in general viewed as the least sustainable option.

Sustainability. This also strengthens massively the resilience of such systems to catastrophic climate changes and other natural or man-made disasters. Interconnected systems are a handicap to change parts into sustainable alternatives. A solution is to make systems independant while making them sustainable. This also strengthens massively the resilience of such systems to catastrophic climate changes and other natural or man-made disasters. [Brend Brunner, Switzerland]

Accept - whole section revised

France]

Hydropower and Bio-energy are very wide terms (used in other sections too), these should be referenced as large-scale hydro and micro-hydro, also any mention of bio-fuels should differentiate between the use of 1st generation (agricultural product), 2nd generation (waste derived) and 3rd generation (algae or other chemical synthesis) production - the former being in general viewed as the least sustainable option.

Any mention of bio-fuels should differentiate between the use of 1st generation (agricultural product), 2nd generation (waste derived) and 3rd generation (algae or other chemical synthesis) production - the former being in general viewed as the least sustainable option.

The goal should not be a "transition to 1.5°C world" but to peak at as low a level as possible (ideally less than 1.5°C, with an overshoot of a bit more) and return to less than about 0.5°C and of a peak warming with Solar Radiation Management in order to limit impacts (especially for avoid irreversible impacts). The level of impacts at 1.5°C will be so much there is really no justification for thinking of 1.5°C as an acceptable long-term stabilisation level. [Michael MacCracken, United States of America]

The goal should not be a "transition to 1.5°C world" but to peak at as low a level as possible (ideally less than 1.5°C, with an overshoot of a bit more) and return to less than about 0.5°C and of a peak warming with Solar Radiation Management in order to limit impacts (especially for avoid irreversible impacts). The level of impacts at 1.5°C will be so much there is really no justification for thinking of 1.5°C as an acceptable long-term stabilisation level. [Michael MacCracken, United States of America]

Small scale renewable energy production certainly has a great potential, especially solar energy and (at least in countries like Sweden) hydropower. One obstacle for the moment in Sweden is the legal system obstructing net "overproduction" of energy, i.e. it is not allowed to produce more than your own consumption and be a net energy provider out on the national transmission grid. If you do that you have to pay extra tax for all energy you produces. These kinds of obstacle need to be reduced. [Malu Winholt, Sweden]

Accept - section has been revised

In contrast with my comments above. The section 4.3.2 "Energy system transitions" is nice and informative. But it is only taking a bit over 2 pages of the chapter. This is extraordinary in a report intended assess climate change mitigation to under 1.5 °C. This chapter needs to expand the section. [Aleksandar Caljo, Spain]

Accept - section has been revised

Chapter 4 does not discuss the feasibility of nuclear and instead refers to AR5 (p.19, lines 12-13), which is a report that extensively discusses nuclear power increase of 2000 Gwe in 20 years followed by a FBR power increase in 70 years. If a doubt exists on the conclusion of this article in a recent article IJGEI V40 N1/2 2017, it was shown by a panel of experts that with the use of breeding reactors it was quite possible to obtain a PWR power increase of 2000 Gwe in 20 years followed by a FBR power increase in 70 years. If a doubt exists on the conclusion of this article in a recent article IJGEI V40 N1/2 2017, it was shown by a panel of experts that with the use of breeding reactors it was quite possible to obtain a PWR

In a recent article IJGEI V40 N1/2 2017, it was shown by a panel of experts that with the use of breeding reactors it was quite possible to obtain a PWR power increase of 2000 Gwe in 20 years followed by a FBR power increase in 70 years. If a doubt exists on the conclusion of this article in a recent article IJGEI V40 N1/2 2017, it was shown by a panel of experts that with the use of breeding reactors it was quite possible to obtain a PWR

It was surprised by the "Energy system transitions" section based on videos I saw about the SR1.5 report. Even though this is a topic of central importance to achieving 1.5°C, the section is very short and seems to be written from a "futuro computer trajectory" perspective rather than the perspective of what can be achieved if governments and businesses made the transition a strong focus. [Lori Goldston, United States of America]

Accept - whole section revised

General comment: As stated in the comments for Chapters 2 and 5, there is some concern of bias evident in the report against nuclear energy, without fair consideration of the associated hazards and expected trade-offs for renewable energy technologies. As a general comment, it is noted that none of the authors or editors listed have a background in nuclear science and yet this technology is mentioned several times in the report. The absence of a scientist in this field can therefore question the report's authority and ability to present all energy technologies in a balanced manner.

Accept - section added on nuclear

These kinds of obstacle need to be reduced. [Mats Winroth, Sweden]

Small scale renewable energy production certainly has a great potential, especially solar energy and (at least in countries like Sweden) hydropower. One obstacle for the moment in Sweden is the legal system obstructing net "overproduction" of energy, i.e. it is not allowed to produce more than your own consumption and be a net energy provider out on the national transmission grid. If you do that you have to pay extra tax for all energy you produces. These kinds of obstacle need to be reduced. [Malu Winholt, Sweden]

Accept - section has been revised

Why are hydro, biomass, and nuclear not discussed here in the 1.5C context? Seems strange to omit these but not other sectors given that all sectors are covered in AR5. Also, hydros is mentioned on p 19 line 52-54. [Farhad Ahanbar, United States of America]

Accept - for hydro and biomass the section discusses developments since AR5. Section added on nuclear

In a recent article - UNEP/GRID A report in 2017 it was shown by a panel of experts that with the use of breeding reactors it was quite possible to obtain a PWR power increase of 2000 Gwe in 20 years followed by a FBR power increase in 70 years. If a doubt exists on the conclusion of this article in a recent article IJGEI V40 N1/2 2017, it was shown by a panel of experts that with the use of breeding reactors it was quite possible to obtain a PWR power increase of 2000 Gwe in 20 years followed by a FBR power increase in 70 years. If a doubt exists on the conclusion of this article in a recent article IJGEI V40 N1/2 2017, it was shown by a panel of experts that with the use of breeding reactors it was quite possible to obtain a PWR power increase of 2000 Gwe in 20 years followed by a FBR power increase in 70 years. If a doubt exists on the conclusion of this article in a recent article IJGEI V40 N1/2 2017, it was shown by a panel of experts that with the use of breeding reactors it was quite possible to obtain a PWR
14251 19 12 19 13

The means for which options like nuclear energy (the capacity additions of which continue to fluctuate (IEA 2017)), hydropower and biomass, we refer to AR5 for an assessment of their feasibility. No, this is unacceptable. Nuclear power needs to be considered. Regardless of the authors’ feeling about nuclear power it needs to be investigated and its contributions discussed properly. If the authors are unfamiliar with nuclear power then they should get an author to contribute to the discussion. Nuclear power is currently contributes about half of the carbon-free energy in the world (hydro being most of the other half) and both need to be discussed in detail, but neither are. This report has found a mind-boggling extreme array of expertise and it may need to add an expert on nuclear power and another on hydropower. I’ve been very impressed with the depth of knowledge on other subjects, but these two topics have not been adequately addressed. [Jason Donev, Canada]

Accept - section added on nuclear

20627 19 13 13

stakeholder would expect an update from AR5 and a diversified list of options. Otherwise discussion would again be constrained to BECCS as a less desirable option from the point of view of impacts. [Hans Forstenr, Germany]

Accept - section has been expanded to include more options and references since AR5

18305 19 13 13 13

Double braking [Witmar Muculmina, Oslo, Norway]

Accept - changed

19721 19 18 18

Section on renewable energy. Note this section needs to (i) address the gender dimensions of access to renewable energy; (ii) address the social inclusion aspects of access to renewable energy and (iii) ensure that States and businesses respect human rights when designing and implementing renewable energy projects. Resources for each of these as follows: [Tara Shine, Ireland]

Noted but these issues are in chapter 5. Box on slums covers to some degree.

19722 19 18 18


Noted but these issues are in chapter 5. Box on slums covers to some degree

19723 19 18 18


Noted but these issues are in chapter 5. Box on slums covers to some degree

19724 19 18 18


Noted but these issues are in chapter 5. Box on slums covers to some degree

11190 19 18 18

Can anything be said in the section on the assumptions used by IAEE for renewable energy costs and how they compare with reality? [Michel Schaeffer, Netherlands]

Noted but not the right place for this.

20628 19 16 24

Again missing the option of CO2 recycling and synthetic fuels as one that would also be applicable to shipping and air traffic. Power to gas technologies are being tested widely and should not be ignored. [Hans Forstenr, Germany]

Accept - section has been revised

10999 19 16 19 18

The section should cover integration challenges at high levels of penetration. [Asha Jim, United Kingdom (of Great Britain and Northern Ireland)]

Accept - section has been expanded

4222 19 18 19 48

The report does not appear to consider some of the limitation risks associated with solar PV, for example:

- The hazardous chemicals required for solar panel manufacturing combined with an absence of many PV companies addressing appropriate recycling, highlights the need for appropriate policies in place to manage this aspect of the life cycle to limit any impact it may have on health or the environment (LID 2012; SVT 2014a; SVT 2014b).

- The highest number of fatalities per TWh for energy sources may be from rooftop solar due to the hazards from falling during installation and the relative high frequency of fatalities from falls (US Department of Labor 2016, 2017; Wang 2008).

- A recent report by the World Bank (2017) states that renewable technologies such as wind, solar, hydropower and electricity systems are actually more material intensive in their composition than fossil-fuel based energy supply systems. It notes that a new set of challenges related to the sustainable development of minerals and resources is likely to result from the increased use of renewable technologies. The report warns that it will be necessary to develop appropriate policies and measures that help ensure that the transition to lower carbon is managed so that it will not negatively impact sustainable development priorities, from environmental and other material impact issues to supporting continued economic and equitable growth, in developing countries. A lack of data on the need for further research and studies on this issue was also noted.

- Following a survey of photovoltaic module manufacturers, none were able to provide documentation to verify that their supply chains do not contain conflict minerals based on the due diligence guidelines set by the OECD. Thus the companies may contribute, directly or indirectly, to armed conflict, infringements of human rights and unpaid economic and social development (SVT 2014a, SVT 2014b: OECD 2016). This point and the three above regarding the hazardous chemicals, challenges of sustainable development of minerals and resources, and possible fatalities can be considered trade-offs and possible risks in the use of this mitigation technology.

References:


2746 19 18 48

Renewable energy could be discussed both as a mitigation and an adaptation option - in most LEDCs, this is how it is discussed and implemented in practice. The discussion here may wish to reflect this. [Penny Linghaut, South Africa]

Accepted - text to reflect the synergies between mitigation and adaptation potential of renewable energy has been added into the SOD.

2236 19 18 48

The entire section Renewable Energy lacks structure and has the character of notes from a brainstorming session. It needs to be rewritten in a more structured way. [Kenneth Moberg, Sweden]

Accept - section has been revised
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1127</td>
<td>19</td>
<td>18</td>
<td>27</td>
<td>47</td>
<td>The structure (energy first then land and ecosystems) makes sense, but I did not find a discussion on the linkages (competition/biomes for food, feed, energy, industrial processes in a bio-economy) in a 1.5 degree scenario. A discussion on the tension between (low-tech, low-input) and high-tech (high-input) agriculture would be useful. E.g., would vertical farming decrease GHG emissions (decreasing transport distances and higher efficiency of water use) or increase them (artificial lighting and other inputs) and thus have a place in a 1.5 degree world or not? The text in 4.3.4.1.4. could be expanded to cover the latter issue. [Rob Swart, Netherlands]</td>
<td>Accepted</td>
</tr>
<tr>
<td>2993</td>
<td>19</td>
<td>19</td>
<td>20</td>
<td></td>
<td>Biomass or bioenergy are not included in the renewable energy options [Maria Puig Arnavat, Denmark] Accept - section added on biomass</td>
<td>Accepted</td>
</tr>
<tr>
<td>11080</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>24</td>
<td>In Van Sluisveld et al. 2016, a detailed comparison of the transformation of energy supply in different scenarios and historic changes is provided. Citing some of their results here could enrich this paragraph significantly. [Jürgen Wachsmuth, Germany]</td>
<td>Accept</td>
</tr>
<tr>
<td>7904</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>24</td>
<td>It would be useful to mention the trends in installed capacity for different RE technologies and show what trends were needed to be kept in warming to 1.5 degree [Westphal Michael, United States of America]</td>
<td>Accept</td>
</tr>
<tr>
<td>7903</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>48</td>
<td>There is no mention of the costs other RE besides solar. There has been a wind revolution too. From REN21 2017: The global weighted average LCOE of onshore wind power for 2016 was 4% lower than 2010 values, and is USD 0.07 per kWh for wind farms commissioned in 2016. [Westphal Michael, United States of America]</td>
<td>Accept</td>
</tr>
<tr>
<td>11061</td>
<td>19</td>
<td>19</td>
<td>35</td>
<td>39</td>
<td>Power and references here: [Jürgen Wachsmuth, Germany]</td>
<td>Accept</td>
</tr>
<tr>
<td>6741</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>48</td>
<td>This section as drafted ignores the rapid uptake of wind, solar and battery technologies as well as the very recent acceleration of RE. It also makes no mention of the dramatic cost declines of renewable energy in recent years such that it is now cost competitive with FF and nuclear power in many parts of the world. It also fails to talk about the substantial co-benefits associated with RE deployment, especially when compared to continued reliance on FF and nuclear. Also, unlike CCS, it is a proven and cost effective technology that avoids CO2 generation and thus should be a priority investment for all those countries that want to avoid warming to 1.5 degree [Westphal Michael, United States of America]</td>
<td>Accept</td>
</tr>
<tr>
<td>19394</td>
<td>19</td>
<td>20</td>
<td>24</td>
<td></td>
<td>If only solar and wind energy have grown exponentially since AIPS, why does the SR.5 take the position that a range of other technologies (bioc EU) would need to show faster growth rates. Perhaps, more studies need to be undertaken to understand why the range of technologies which are growing slower (concentrated solar, bioenergy and ocean energy) are growing slow to growth, rather than suggesting that they should. [Sumetha Happa-Gajar, India]</td>
<td>Accept</td>
</tr>
<tr>
<td>921</td>
<td>19</td>
<td>21</td>
<td>21</td>
<td></td>
<td>Care is needed when interpreting the IEA analysis of offshore wind; they report on the decline in installations in 2016. In contrast, 2015 saw an over double of installation. [David Infield, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accepted</td>
</tr>
<tr>
<td>558</td>
<td>19</td>
<td>21</td>
<td>22</td>
<td></td>
<td>Only solar and wind are on track to reach a 2C pathway. This is misleading because according to the 100% WWS roadmaps (e.g., Jacobson et al. 2017, reference above), there is no growth in new hydro/euro dams needed. geothermal growth reawed is only modest, and no bioenergy reawed at all [Mark Jacobson, United States of America]</td>
<td>Accepted</td>
</tr>
<tr>
<td>Comment No</td>
<td>From Page</td>
<td>From Line</td>
<td>To Page</td>
<td>To Line</td>
<td>Comment</td>
<td>Response</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-----------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>6742</td>
<td>19</td>
<td>21</td>
<td>19</td>
<td>22</td>
<td>According to the IEA (2017), only solar energy and onshore wind energy are on track to reach a 2°C pathway. The IEA is not a neutral and scientific source for these analyses.</td>
<td>Accept - section revised</td>
</tr>
<tr>
<td>11189</td>
<td>19</td>
<td>21</td>
<td>19</td>
<td>22</td>
<td>According to the IEA, only solar energy and onshore wind energy are on track to reach a 2°C pathway. What does “on track” mean in this context? When 2°C is pathway is used?</td>
<td>Accept - section revised</td>
</tr>
<tr>
<td>13054</td>
<td>19</td>
<td>21</td>
<td>19</td>
<td>22</td>
<td>How this “track” has been evaluated in Chapter 3? Details on the point would be useful.</td>
<td>Accept - section revised</td>
</tr>
<tr>
<td>6792</td>
<td>19</td>
<td>26</td>
<td>19</td>
<td>27</td>
<td>The price given here is not for “solar PV” but for “solar module” which is just one element of a PV system. PV system costs have decreased as well, but are not only dependent on hardware costs, but on soft costs as well.</td>
<td>Accept - removed price as not needed</td>
</tr>
<tr>
<td>6793</td>
<td>19</td>
<td>26</td>
<td>19</td>
<td>33</td>
<td>The description of world-wide PPAs, which are in the range of USD 25 to 75/MWh are missing completely.</td>
<td>Noted but not the right place for this</td>
</tr>
<tr>
<td>6743</td>
<td>19</td>
<td>26</td>
<td>19</td>
<td>27</td>
<td>The largest growth factor since AR5 has been the dramatic reduction in the cost of solar PV to €1.15 USD/Wp-1 (REN21 2017). The €1.15 USD/Wp-1 data refers to end 2016.</td>
<td>Accept - removed price as not needed</td>
</tr>
<tr>
<td>10853</td>
<td>19</td>
<td>26</td>
<td>19</td>
<td>27</td>
<td>The solar PV cost decline, however it is not specified that here solar PV module cost data is meant - the total system cost are higher.</td>
<td>Reject - not supported by literature on the comparative cost of energy sources across the world</td>
</tr>
<tr>
<td>7909</td>
<td>19</td>
<td>26</td>
<td>19</td>
<td>27</td>
<td>This appears to be a module (not system) market price, as it should be updated to the current level of $0.34/Wp (latest $0.25) reported frequently in PV World.</td>
<td>Accept - removed price as not needed</td>
</tr>
<tr>
<td>7963</td>
<td>19</td>
<td>26</td>
<td>19</td>
<td>27</td>
<td>This appears to be a module (not system) market price, as it should be updated to the current level of $0.34/Wp (latest $0.25) reported frequently in PV World and other trade literature.</td>
<td>Accept - removed price as not needed</td>
</tr>
<tr>
<td>10584</td>
<td>19</td>
<td>26</td>
<td>19</td>
<td>27</td>
<td>We also need further articles on the excellent IE based outlooks for grid-scale renewables (<a href="http://dx.doi.org/10.1056/enlight2015.12.077">http://dx.doi.org/10.1056/enlight2015.12.077</a>) and islands (<a href="http://dx.doi.org/10.1016/j.enpol.2016.03.043">http://dx.doi.org/10.1016/j.enpol.2016.03.043</a>)</td>
<td>Noted. Removed price as not needed</td>
</tr>
<tr>
<td>7902</td>
<td>19</td>
<td>26</td>
<td>19</td>
<td>27</td>
<td>Finally, it would also cost under $0.20/Wp by 2020.</td>
<td>Accept - removed price as not needed</td>
</tr>
<tr>
<td>4963</td>
<td>19</td>
<td>27</td>
<td>19</td>
<td>27</td>
<td>Use USD currency format (Kazuki Takeda, Czech Republic)</td>
<td>Accept - removed price as not needed</td>
</tr>
<tr>
<td>14252</td>
<td>19</td>
<td>27</td>
<td>19</td>
<td>27</td>
<td>USD or Euros? Be consistent from one chapter to the next.</td>
<td>Accept. Removed price as not needed</td>
</tr>
<tr>
<td>14253</td>
<td>19</td>
<td>27</td>
<td>19</td>
<td>27</td>
<td>The line uses 14 USD which is an odd mix of the European way of writing a decimal with a U.S. currency. Please use - or - Consistently I know that’s hard with coordinating different authors!</td>
<td>Accept. Removed price as not needed</td>
</tr>
<tr>
<td>754</td>
<td>19</td>
<td>27</td>
<td>19</td>
<td>27</td>
<td>It states 0.41 USD it should read 0.41 with a point</td>
<td>Accept. Removed price as not needed</td>
</tr>
<tr>
<td>13513</td>
<td>19</td>
<td>28</td>
<td>19</td>
<td>29</td>
<td>Renewable energy exploitation in developing countries is often a “losing-then-fighting-for-space” ready for exploitation at a relatively low cost.</td>
<td>Accept - changed</td>
</tr>
<tr>
<td>755</td>
<td>19</td>
<td>30</td>
<td>19</td>
<td>32</td>
<td>The statement that “and have already provided many remote communities with energy independence” is highly unlikely, and needs a few citations</td>
<td>Accept - section revised</td>
</tr>
<tr>
<td>3811</td>
<td>19</td>
<td>33</td>
<td>19</td>
<td>33</td>
<td>There is need for classification to support the statement made in the last Chap. (Victor Orugomu, Kenya)</td>
<td>Accept - section revised</td>
</tr>
<tr>
<td>6543</td>
<td>19</td>
<td>35</td>
<td>19</td>
<td>39</td>
<td>The statement is odd. Solar in northwestern Europe is not a surprise at all.</td>
<td>Accept - section revised</td>
</tr>
<tr>
<td>2237</td>
<td>19</td>
<td>36</td>
<td>19</td>
<td>37</td>
<td>Has not policy instruments had an impact on the technology attractiveness? A reference is needed.</td>
<td>Accept - section revised</td>
</tr>
<tr>
<td>6745</td>
<td>19</td>
<td>36</td>
<td>19</td>
<td>39</td>
<td>Another important factor in public acceptance, in particular for wind energy, though research indicates that financial participation and serious community engagement can be effective in mitigating resistance.</td>
<td>Accept - section revised</td>
</tr>
</tbody>
</table>
Comment | Response
---|---
14205 | Accepted - added other renewables only as that is the sentence, not nuclear
14079 | Accept - section has been revised
15710 | Accept - section has been revised
15405 | Accept - section has been revised
15406 | Accept - section has been revised
15410 | Accept - section has been revised
12609 | Accept - section has been revised
559 | Accept - section has been revised
10285 | Accept - section has been revised
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>14259</td>
<td>19</td>
<td>42</td>
<td>19</td>
<td>43</td>
<td>&quot;Studies estimating the use of renewable energy in the future, either at the global or at the national level, are plentiful and considerable debate exists on whether a fully renewable energy or electricity system, also excluding biomass, is possible (Jassonison et al. 2015) or not (Heard et al. 2017); Clark et al. (2017), and by what year. I am uncomfortable with this treatment of the controversy. Jacobson’s paper has been widely hailed as wonderful, but not by people who have a deep understanding of the electrical grid. Both Heard et al and Clark et al have raised serious objections to the modeling problems put forth in Jacobson’s paper. I strongly urge the authors of this document to read all three of those papers in depth and take a firmer stand on this issue. My opinion is that Jacobson’s work is a magical thinking, but encourage the authors of this paper to read all these papers and draw their own conclusions. If their paper were true, it simply doesn’t seem to be based on sound modeling.” Please also consider looking at: Pacala, Stephen, and Robert Stouffer. “Stabilization wedges: solving the climate problem for the next 50 years with current technologies.” Science 330, no. 6006 (2014): 968-972.</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>11101</td>
<td>19</td>
<td>43</td>
<td>19</td>
<td>43</td>
<td>Why are studies “also excluding biomass” singled out? Biomass can be a renewable source of energy, is a substantial part of the global energy mix and helpful in dealing with interconnectivity. (Michael Schaeffer; Netherlands)</td>
<td>Accept - changed</td>
</tr>
<tr>
<td>922</td>
<td>19</td>
<td>43</td>
<td>19</td>
<td>43</td>
<td>Note that these studies pay no or limited attention to the technical requirement to operate a dynamically stable power system. (David Infield, United Kingdom; &amp; Great Britain and Northern Ireland)</td>
<td>Accept as text did include but has now been expanded</td>
</tr>
<tr>
<td>2035</td>
<td>19</td>
<td>45</td>
<td>19</td>
<td>45</td>
<td>This does not clearly explain the meaning and importance of the concept “disruptive innovation.” (Kenneth Möllersten, Sweden)</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>2597</td>
<td>19</td>
<td>47</td>
<td>19</td>
<td>47</td>
<td>It should be mentioned that the goal for Denmark in 2014 is not only 100% renewable electricity but also heating. (Mare Pujg Arnal, Denmark)</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>14256</td>
<td>19</td>
<td>47</td>
<td>19</td>
<td>48</td>
<td>Several countries have adopted targets of 100% renewable electricity by e.g. 2035 (Denmark). Once again, hydro is ignored. Please look at countries like Laos. (Jason Done, Canada)</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>14257</td>
<td>19</td>
<td>47</td>
<td>19</td>
<td>48</td>
<td>“Several countries have adopted targets of 100% renewable electricity by e.g. 2035 (Denmark). Also, this statement is misleading, we need carbon free, whether it’s renewable or not is completely beside the point. We need to get away from political catchphrases and focus on the science in this report. We can’t ignore politics, and political science must be considered (and is elsewhere, quite well I may add!), but we must focus on our goal of reducing GHGs and not get distracted by a fascination for ‘renewable’. Framing is very important. (Jason Done, Canada)</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>14258</td>
<td>19</td>
<td>47</td>
<td>19</td>
<td>48</td>
<td>Several countries have adopted targets of 100% renewable electricity by e.g. 2035 (Denmark). Denmark’s policy is quite misleading as it is not in any way shape or form an independent grid. Denmark has deep interties to other electricity grids to allow it to continue to have electricity when the wind isn’t blowing. This supergrid situation is not widely available outside of Europe. To use Denmark as a case study is misleading and mis-informative. (Jason Done, Canada)</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>14359</td>
<td>19</td>
<td>43</td>
<td>19</td>
<td>48</td>
<td>If several countries have adopted goals for 100% renewable energy, then why mention just Denmark? (Sumeela Palas Gajan, India)</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>756</td>
<td>19</td>
<td>46</td>
<td>19</td>
<td>46</td>
<td>It states e.g. 2035 (Denmark) is this not clear, does it mean – electricity e.g. Denmark by 2035 ? (Marie Reim, United Kingdom; of Great Britain and Northern Ireland)</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>10921</td>
<td>19</td>
<td>48</td>
<td></td>
<td></td>
<td>Cost of solar panels decreases 10% per year and batteries decrease steeply by 16% (Tony Selka 2015). Those decreases will continue to decrease as they are technologies (J. Doyne Farmer; &amp; François Lafond) and a tipping point will be reached when solar with batteries and demand response management through smart metering gives an electricity cost per kWh that is lower than grid transport cost and cheaper than diesel generators. Find one will happen around 2022 and second one already happened as a matter of fact, which is great news for developing countries. Here it is mainly the purchasing cost/ investment that is a barrier, but financing schemes are a solution here. The second issue is that people need to be aware that solar/battery is cheaper than diesel generators. Both financing this clear business case and information are easy low hanging fruits. There is also a counter-productive step that some governments have taken or are about to take: Import duties and anti-dumping duties on solar PV. While protecting short-term local producers, these taxes (and also the threats to tax) are a massive hurdle and imposition of energy transition to renewable energy. Some for stringent and discouraging permitting rules or anti-renewables regulations. Such anti-humanitarian renewable energy hindering should be forbidden at United Nations level and at national levels too! (Beat Brunner, Switzerland)</td>
<td>Noted</td>
</tr>
<tr>
<td>10856</td>
<td>19</td>
<td>51</td>
<td>19</td>
<td>54</td>
<td>Brewer et al. (2013; 10 (10) 2885) have derived a high battery storage demand for the future, an updated energy transition study of the same authors in Progress in Photovoltaics’ provides much more detail on the demand development (the accepted manuscript can be provided upon request) (Christian Brewer; Finland)</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>20629</td>
<td>19</td>
<td>51</td>
<td>20</td>
<td>42</td>
<td>Missing storage options of synthetic gas in the natural gas grid and associated storage sites. It would allow storage of renewable energy and use of conventional technology. Synthetic fuels should also be discussed for use in ground transportation, air traffic and shipping. Use of biofuels comes with drawbacks and conflict in land use as well as risks for ecosystems and biodiversity, this should be addressed as well. For these purposes provision of renewable energy in excess of conventional demand requires consideration. (Hans Pfeffer, Germany)</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>2598</td>
<td>19</td>
<td>51</td>
<td>20</td>
<td>6</td>
<td>Maybe it would be worth introducing the concept/technology “vehicle-to-grid” (aka V2G or “EV-to-grid”). (Mare Pujg Arnal, Denmark)</td>
<td>Accept - section has been revised</td>
</tr>
</tbody>
</table>
The narrative veers from renewables—some renewable, some dispatchable—to the unwarranted tacit assumption that bulk electrical storage will be required for reliable grid integration. Neither the literature nor modern experience (with at least four EU countries with modest or no hydropower—Portugal, Denmark, Scotland, Spain) nor the available bulk storage additions, competitive prices, and superior reliability supports that assumption. There are in fact at least ten kinds of grid flexibility resources, many with large quantities but negative or low costs. Bulk storage is currently the costliest of these, and may even be necessary for example, the effective operation (Portugal) can be 100% renewable-powered year-round in 2020 with no bulk storage and excellent economics. The evidence for these statements is far too voluminous to marshal here, but if you'd like a doo-doo-page summary currently in submission to EL J., please write me at amory@rmi.org. Meanwhile, just kindly recall that the US National Renewable Energy Laboratory's 2010 REFS multivolume report (https://www.nrel.gov/analysis/re_futures/, which cites the many peer-reviewed (journal articles summarizing this extremely detailed and extensively peer-reviewed study) confirmed 95-95% renewable power's US practicability with 1% storage much less than paired bidirectional interface electric vehicles could provide. Lovins & RMI (2011), using the same state-of-the-art grid simulation model but allowing half the renewables to be distributed, cut that need in half without counting most of the grid's flexibility resources exhausted since then. [Amory Lovins, United States of America]

I would suggest to edit a sentence on the demonstrated fact that PHS (world) potential is insufficient for an energy system strongly based on renewables. A good reference to start from is blanco and Fajr, RSER 81, 2018. [Fabio Monforti-Ferrario, Italy]

The narrative veers from renewables—some renewable, some dispatchable—to the unwarranted tacit assumption that bulk electrical storage will be required for reliable grid integration. Neither the literature nor modern experience (with at least four EU countries with modest or no hydropower—Portugal, Denmark, Scotland, Spain) nor the available bulk storage additions, competitive prices, and superior reliability supports that assumption. There are in fact at least ten kinds of grid flexibility resources, many with large quantities but negative or low costs. Bulk storage is currently the costliest of these, and may even be necessary for example, the effective operation (Portugal) can be 100% renewable-powered year-round in 2020 with no bulk storage and excellent economics. The evidence for these statements is far too voluminous to marshal here, but if you'd like a doo-doo-page summary currently in submission to EL J., please write me at amory@rmi.org. Meanwhile, just kindly recall that the US National Renewable Energy Laboratory's 2010 REFS multivolume report (https://www.nrel.gov/analysis/re_futures/, which cites the many peer-reviewed (journal articles summarizing this extremely detailed and extensively peer-reviewed study) confirmed 95-95% renewable power's US practicability with 1% storage much less than paired bidirectional interface electric vehicles could provide. Lovins & RMI (2011), using the same state-of-the-art grid simulation model but allowing half the renewables to be distributed, cut that need in half without counting most of the grid's flexibility resources exhausted since then. [Amory Lovins, United States of America]

I would suggest to edit a sentence on the demonstrated fact that PHS (world) potential is insufficient for an energy system strongly based on renewables. A good reference to start from is blanco and Fajr, RSER 81, 2018. [Fabio Monforti-Ferrario, Italy]

I would suggest to edit a sentence on the demonstrated fact that PHS (world) potential is insufficient for an energy system strongly based on renewables. A good reference to start from is blanco and Fajr, RSER 81, 2018. [Fabio Monforti-Ferrario, Italy]
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>16411</td>
<td>20</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>The new ultra-capacitor batteries do not require lithium or other rare elements—and are reaching very high energy densities that are comparable to lithium batteries. If they are not based on chemical reactions, these new ultra-capacitor batteries can be fully discharged (unlike lithium batteries), and do not deteriorate after 10000 or so cycles, and can be very rapidly recharged. So, I'd suggest that this information of a potential lithium limit is likely to be overcome—and such a transition could occur quite rapidly. What is needed is a mechanism for promoting up and coming technologies that is much more aggressive than the quite slow development of the Gates et al. effort that was announced in Paris. [Michael MacCracken, United States of America]</td>
<td>Accept - section has been revised</td>
</tr>
<tr>
<td>923</td>
<td>20</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>[Josep Cusachs] [United Kingdom of Great Britain and Northern Ireland] Taken into account.</td>
<td>Crude text is correct</td>
</tr>
<tr>
<td>926</td>
<td>20</td>
<td>5</td>
<td>20</td>
<td>5</td>
<td>When the author mentions that one study says that combining PV with HT fuel cells would boost overall lifecycle GHG emissions, this statement seems weak. Does this study mention in this report? If so, discuss it in the report. Then explain how these technologies work in tandem or in the joint usage of materials for them can lower lifecycle GHG emissions. [Elizabeth Atherton, United States of America]</td>
<td>Accepted - section has been revised</td>
</tr>
<tr>
<td>13057</td>
<td>20</td>
<td>6</td>
<td>20</td>
<td>20</td>
<td>Reference of Balmert et al. 2016 is missing; as too many other references in the following. I will not mention all the reference missing, please check carefully the list [Casemiro Stefano, Italy]</td>
<td>More references added</td>
</tr>
<tr>
<td>12810</td>
<td>20</td>
<td>6</td>
<td>20</td>
<td>7</td>
<td>The cost of the technology not communicated. [Yana POPKOSTOVA, France]</td>
<td>Accepted - section has been revised</td>
</tr>
<tr>
<td>3074</td>
<td>20</td>
<td>7</td>
<td>20</td>
<td>12</td>
<td>12 The sentence is hard to understand. There is a high agreement that mitigation and adaptation options for thermossic generation and if, that remains based on fossil fuels, CCS need to consider increasing water shortages. Do you mean generation based on fossil fuels? Technically thermosic refers to a voltage difference created by a temperature difference, (spatially across a semiconductors) or two thermosic materials. If you understand you correct I would rephrase from the term &quot;thermostatic&quot; and stick with the term &quot;thermosic&quot; for the method and stick with the term &quot;thermosic&quot; for the method of water management. [Christopher statute, Canada]</td>
<td>Thermosic has been changed to thermal electric generation</td>
</tr>
<tr>
<td>11191</td>
<td>20</td>
<td>9</td>
<td>20</td>
<td>20</td>
<td>The section on CCS in the power sector could highlight the risk of lock-in to fossil fuel infrastructure, or the last opportunity of using CCS projects for the power sector when they could be used to provide negative emissions through BECCS or DAC with CCS. [Michiel Schiffer, Netherlands]</td>
<td>No references provided. It is more of a point for chapter 2 anyway</td>
</tr>
<tr>
<td>7097</td>
<td>20</td>
<td>9</td>
<td>20</td>
<td>9</td>
<td>What about DSM from household electricity demand? If it is not in the winner list due to uncertain and complicated it is (E E Nyholm). The role of Swedish angle-family dwellings in the electric system - The importance and impacts of solar photovoltaics, demand response, and energy storage. [Chalmers University of Technology, 2016, and references here]. maybe this could be clearly stated? [Erica Maria, Sweden]</td>
<td>Taken into account. This is addressed in the buildings section (4.3.4)</td>
</tr>
<tr>
<td>6794</td>
<td>20</td>
<td>9</td>
<td>20</td>
<td>32</td>
<td>What is missing is the incompatibility with fracking. What about the additional energy demand for this technology? How does this influence the overall equation? [Arnolv Jürgen, Radix, Italy]</td>
<td>Taken into account. This was all extensively discussed in the SRESCCS (2005) and the AR5.</td>
</tr>
<tr>
<td>6746</td>
<td>20</td>
<td>9</td>
<td>20</td>
<td>22</td>
<td>This is an unbalanced view of CCS (although it acknowledged that costs here), especially as very optimist. forecasts including by the IPCC and IEA has not materialized and several major CCS test projects have been recently terminated. It also does not mention the prohibitive costs and delays about the single power sector CCS comes on line so far - despite its massive subsidies and technological circumnstances (using captured CO2 in EGIR). The latter model also increases GHG emissions through increased oil production. [Jennifer Morgan, Netherlands]</td>
<td>Party accept. Other reviewers found our assessment unbalanced the other way. We will mention more about the problems that power-sector CCS projects have encountered.</td>
</tr>
<tr>
<td>9105</td>
<td>20</td>
<td>9</td>
<td>20</td>
<td>20</td>
<td>There are evidences on CCS needed on 1.5 degree target in economic modeling in global scale. Tanemura, T. W. Nozawa, and S. Manage, 2017: &quot;Evaluation of the Ocean Ecosystem: Climate Change with Backstop Technologies&quot; Applied Energy, Vol. 205, pp.428-438 [Teisaku Tanemura, Japan]</td>
<td>Noted. The reference was considered but does not add any insights to the assessment of feasibility of CCS.</td>
</tr>
<tr>
<td>10555</td>
<td>20</td>
<td>9</td>
<td>20</td>
<td>30</td>
<td>Recent research has shown that CCS is not a viable option in the long term due to the strong rebound activity effect, besides all of the technical and economic restrictions (see the work of Andrea Pazani and other economic [Jose Antonio Puppim de Oliveira, Brazil]</td>
<td>Noted, but not followed up on. We could not find the point made in what we think is the reference and actually no economic restrictions like Andrea Pazani and others.</td>
</tr>
<tr>
<td>1748</td>
<td>20</td>
<td>9</td>
<td>20</td>
<td>32</td>
<td>Perhaps mention the Allam cycle (Alam et al., Energy Procedia, Volume 114, 2017, Pages 5484-5556), as a possible disruptive technology ([Jordaan, United States of America)]</td>
<td>Noted. Interesting technology but the reference is unfortunately not peer-reviewed.</td>
</tr>
<tr>
<td>2789</td>
<td>20</td>
<td>9</td>
<td>20</td>
<td>32</td>
<td>i) The concept of 1.5°C the prospects for CCS are bleaker yet. The economic depend on capture from CO2 rich emissions streams (esp. coal and gas fired generator) and an economic value for the stored CO2 (as for enhanced oil recovery). For a 1.5°C scenario no new fossil fired generator plant will operate for its full design life so CCS must be retrofit and be amortised over a shorter period thus raising the cost. In addition, the virtual phase-out of oil means that revenue from enhanced oil recovery disappears. [Eric Hales, America]</td>
<td>Rejected. The modelling studies in Chapter 2 indicate a significant role for CCS, even in the power sector, and there is a lot of literature, also non-AM-based, backing this up. No references provided leading to a different conclusion.</td>
</tr>
<tr>
<td>4094</td>
<td>20</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>Change in reference to &quot;fixed&quot; to &quot;consistent with flexibilities&quot;. [Alain James, Commonwealth Scientific and Industrial Research Organization, Australia]</td>
<td>Accept. This</td>
</tr>
<tr>
<td>13058</td>
<td>20</td>
<td>10</td>
<td>20</td>
<td>32</td>
<td>Since CCS is a really key technology for 1.5°C scenarios, I believe that the evaluation of the state of the art and perspectives of this technology deserve more space, in order to provide useful information on the different aspect that limit the expansion of this technology. Although something on CCS has been written in par. 4.2.2.3, here and in 4.5.6, the analysis is too weak and with many repetitions. As an example, I believe that the problem of the storage of CO2 needs more attention and deserves a separate chapter, independent from the source CO2 captured (power sector, BEECS or DACs) [Casemiro Stefano, Italy]</td>
<td>Accept, we have made efforts to understand the treatment of CCS through chapter 4 and the SR1.5.</td>
</tr>
<tr>
<td>19299</td>
<td>20</td>
<td>10</td>
<td>20</td>
<td>32</td>
<td>In my opinion, CCS should not be presented as a mitigation solution without at least mentioning its drawbacks (i.e. the scalability of storage) [Charlotte Bataille, Canada]</td>
<td>We are mentioning risks associated with storage as part of this feasibility assessment. The issue is that most of the literature, including earlier IPCC assessments, indicate that storage, if done well, is sufficiently permanent.</td>
</tr>
<tr>
<td>7906</td>
<td>20</td>
<td>10</td>
<td>20</td>
<td>32</td>
<td>CCS has not been deployed at scale. True, but this is an overstatement. There is very little CCS to date, and the section should actually discuss how many CCS plants are actually being commissioned, commissioned. In terms of membranes for CCS, are the author referring to an implied carbon sink? At what point is CCS even viable? Certainly, we should not be advocating for enhanced oil recovery as a revenue stream. The social cost of the oil construction would need to be factored in. [Wayne Michael, United States of America]</td>
<td>Rejected. Details have been included.</td>
</tr>
<tr>
<td>13059</td>
<td>20</td>
<td>10</td>
<td>30</td>
<td>14</td>
<td>references are needed on the &quot;significant developments of the CCS in the power sector&quot; (i.e. number of projects, capacity, etc.) [Casemiro Stefano, Italy]</td>
<td>Taken into account. The sentence was removed as it is superfluous.</td>
</tr>
<tr>
<td>16412</td>
<td>20</td>
<td>10</td>
<td>30</td>
<td>14</td>
<td>Have not most of the CCS developments been negative (e.g., projects in US given up, etc)? I think it needs to be said that there is little likelihood that this technology will become feasible at a large scale at acceptable cost and that existing coal-fired power plants will (just) need to be abandoned or fitted today with biomass. It would seem that too much money is being wasted on CCS and the false hope that it will work is delaying important decisions and conversion to renewables. The favorable indication in the next paragraph sounds like wishful thinking and too much focus on keeping old technologies existing to be phased out. [Michael MacCracken, United States of America]</td>
<td>Taken into account. The sentence was removed.</td>
</tr>
<tr>
<td>6747</td>
<td>20</td>
<td>10</td>
<td>30</td>
<td>14</td>
<td>The only &quot;significant&quot; developments of CCS in the power sector over the years have been a series of high-profil projects cancellations. We still don't have a single fully integrated commercial-scale power plant capturing, transporting and storing its emissions. List of cancelled projects (as for 2016) can be found here: <a href="http://sequestration.mit.edu/tools/projects/index_cancelled.html">http://sequestration.mit.edu/tools/projects/index_cancelled.html</a>. This list doesn't include the cancellation of Kemper in the US and projects in the EU in 2017. [Jennifer Morgan, Netherlands]</td>
<td>Taken into account. Sentence is removed.</td>
</tr>
<tr>
<td>2239</td>
<td>20</td>
<td>13</td>
<td>20</td>
<td>14</td>
<td>The IPCC should inform what significant developments have occurred this year generally. [Janeth Mildersten, Sweden]</td>
<td>Taken into account. This sentence is removed.</td>
</tr>
</tbody>
</table>
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
2240 | 20 | 14 | 20 | 15 | What is the considerably advancement made up of, what areas? The technology has been mature enough to capture and store CO2 in Norway for over a decade. [Kenneth Möllersten, Sweden] | See comment 13059
17333 | 20 | 15 | 20 | 15 | What are the reasons for not in the cost, are they any available options to reduce the cost? [Harinayaka Gupta, India] | See comment 927
927 | 20 | 15 | 20 | 15 | Why do the costs of CO2 emissions to the least important and therefore advances through technological advances and Moore's Law. Perhaps it would be worth mentioning the most expensive part of this process. It is still the sequestration of the CO2 from the flare gases? It was about 10 years ago. [Elizabeth Aldrich, United States of America] | Accept, more details are given. In fact, the text was not correct according to Rubin et al (2015); statement costs have stayed roughly the same.
2241 | 20 | 15 | 20 | 15 | So how much did it cost and what does that imply? Why did costs fall, did technology develop backwards? [Kenneth Möllersten, Sweden] | See comment 927
13060 | 18 | 20 | 20 | 22 | According to IEA (COC 2014), there has been a large number of projects to estimate CO2 storage potential, in some cases, conflicts with each other, despite being of similar values and covering comparable areas. For example, some estimates of potential for individual countries or regions were larger than those for the entire world [Benson and Cook, 2009; Brandt et al., 2011]. Consequently, there remains uncertainty about what different methods to estimate potential are actually measuring, which methods are most appropriate in given settings, and whether the estimates produced by these methods provide a sound basis for policy making. | Accept, see comment 6088
20870 | 20 | 19 | 20 | 21 | The sentence on communication strategies for CO2 storage projects could be read as an appeal for propaganda. It is important to give a reason for why an effective communication strategy is required for geological CO2 storage. "... in order to prevent public resistance and increase social acceptance by transferring knowledge and thus avoiding misapprehensions, we are often based on a lack of understanding of the physics-chemical working principles of geological CO2 storage." [Daniel Sulter, Switzerland] | Accept, text revised (but in a way briefer than done here)
2242 | 20 | 19 | 20 | 21 | What are those insights and what can be said about decision makers that did and did not, respectively, notice? What is meant by "notice"? [Kenneth Möllersten, Sweden] | Accept, text revised. No room unfortunately to go into the insights.
11062 | 20 | 1 | 3 | Please check Peters et al. 2017 is a meaningful reference here (see above). Maybe they refer to some primary source? [Jakob Wachsmuth, Germany] | Noted. Peters text is broad but infers that resource limitations need to be considered.
11063 | 20 | 10 | 20 | 22 | Pushing CCS in the power sector may also pose a barrier to a fast and complete decarbonisation of the electricity sector, e.g. based on renewables. This is a very critical issue given the need for the CCS technology in general and should be carefully discussed. [Jakob Wachsmuth, Germany] | Noted, but not aware of references making this point.
13301 | 20 | 21 | 20 | 21 | It is quite obvious that "not all decision-makers have taken notice" of the very few experiences of communication that have been done, for quite a novel oil extraction technique. The fact that EOR negates any climate benefit of CCS should be mentioned wherever the report makes reference to EOR. | Accept, see comment 13063
6148 | 24 | 25 | 20 | 25 | Not true. Governments have put a lot of money on the table in some countries and CCS will not get the ground out due to technical reasons and dramatic cost overruns. The industry is expecting governments to cover the entire additional costs of CCS and, in some cases, accept any liability associated with stored CO2. This also leads to recognition that storing CO2 in CC2 projects is not cost-effective in the power sector. | Accept, text revised. “We are not sufficiently compensated by market or government incentives”. [Caserini Stefano, Italy] | Noted. Peters text is broad but infers that resource limitations need to be considered.
4865 | 24 | 20 | 24 | 25 | ...mainly because, first mover demonstration projects in different sectors and development of Transport and Storage infrastructure have not been supported and the incremental costs are not compensated by incentives [IEA 2011] [Wittman, Mass, Netherlands] | Taken into account. The point is fair, but we need to be brief and the earlier formulation also covered the points made. The different sector argument belongs in the section on industry (4.3.5) will be picked up there.
20871 | 20 | 24 | 20 | 32 | There should be an analysis of the logistic problems: CO2 storage site are not available for all the sites where power plants are located and needed. The countries of areas without the possibility of CCS, because too far from a CO2 storage, will have greater difficulties in decarbonizing the power sector. | Accept, text included on regional availability of storage capacity
13063 | 20 | 24 | 20 | 32 | The paragraph has a pessimistic touch giving the impression that CCS is not economically viable. On the contrary, CCS is a commercially proven technology that needs a suitable economic framework in which the external costs of CO2 emissions are internalized. Compare also page 33, lines 26-47, where a much more optimistic assessment of the recent advances in CCS is given. [Daniel Sulter, Switzerland] | Accept, taken into account. Text referred to on page 33 will be integrated in this section (to repair repetition and inconsistencies). As for the pessimistic tone, we will look at it but other reviewers feel that we are too optimistic.
928 | 24 | 20 | 20 | 32 | Have CCS projects been cancelled due to the lack of cost? Were these really EOR projects that were relying on the injected CO2 to enhance oil recovery? Have EOR projects been terminated because the CO2 was staying in the reservoirs? Carbon credit systems have even been set up to allow carbon crediting of this type of sequestrated carbon in Alberta. Since oil prices have dropped, perhaps these CCS projects are now economically unviable? | Reject. It is the way it is stated: even with EOR, CCS in the power sector is not always economically viable and needs additional support, which is insufficiently given.
13063 | 20 | 25 | 20 | 25 | More information of the full scale demonstration project should be added to understand its importance (i.e. capacity, Mtoy of CO2 stored, etc.) | Accept, limited more details will be given.
6098 | 20 | 25 | 20 | 25 | There are two full-scale projects now. Petra Nova came online in January 2017; Tim Otten, United Kingdom (of Great Britain and Northern Ireland) | Accept, will be corrected.
4873 | 20 | 25 | 20 | 26 | Two full-scale demonstration projects (Boundary Dam and Petra Nova). Also reference to GCCSI 2017 in final report [Wittman, Mass, Netherlands] | Accept, see comment 6088
1943 | 30 | 25 | 27 | EOR makes economic sense, but it negates climate benefit. In the case of Wybum CO2 project, for example, it is shown that 1 kg of CO2 injected allows to recover 0.97 kg of supplementary oil (See Greenpeace 2008 report: False Hope). The combustion of that oil will lead to emissions of 3.02 kg CO2. | Accept, see comment 6749
30321 | 30 | 25 | 27 | There are two large-scale demonstration plants in operation in the power sector: Boundary Dam in Canada and Petra Nova in the United States. [Marine Gorner, France] | Accept, see comment 6088
7093 | 30 | 25 | 28 | There are now two. Petra Nova became operational in January 2017; Jasmin Kemper, United Kingdom (of Great Britain and Northern Ireland) | Accept, see comment 6088
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>6749</td>
<td>20</td>
<td>25</td>
<td>20</td>
<td>28</td>
<td>The mention of EOR should include mention of how it can replace any carbon benefit associated with storage, not to mention the role of storing carbon in depleted oil and gas fields, which are often replenished with abandoned wells. The statement here is that at best moment, CCS can make only work in applications where captured CO2 is sold for EOR and EGR purposes and that runs entirely counter to the supposed climate benefit of CCS. [<a href="http://www.greenpeace.org.uk/en/wp-content/uploads/Giordano/Global%20oil%20and%20gas%20captured%20CO2%20scam.pdf">http://www.greenpeace.org.uk/en/wp-content/uploads/Giordano/Global%20oil%20and%20gas%20captured%20CO2%20scam.pdf</a> and <a href="http://pubs.acs.org/doi/abs/10.1021/acs.estlett.5b00209h">http://pubs.acs.org/doi/abs/10.1021/acs.estlett.5b00209h</a> See, e.g., Jaramillo et al. (2005), Life cycle inventory of CO2 in an Enhance Oil Recovery System. Available at: [<a href="http://pubs.acs.org/doi/abs/10.1021/la050317b">http://pubs.acs.org/doi/abs/10.1021/la050317b</a> (Jennifer Morgan, Netherlands).]</td>
<td>Accepted, text included on this. However, whether oil from EOR increases emissions does depend on the fuel it is replacing. A reference will be included.</td>
</tr>
<tr>
<td>18097</td>
<td>20</td>
<td>25</td>
<td>20</td>
<td>26</td>
<td>Not a huge difference, but important in the context: There are currently two industrial-scale power plant CCS applications: Boundary Dam (CA) and Petra Nova (US). (Elle Lefevre, France)</td>
<td>Accepted, see comment 6068</td>
</tr>
<tr>
<td>20201</td>
<td>20</td>
<td>29</td>
<td>20</td>
<td>32</td>
<td>...as mentioned</td>
<td>Editorial</td>
</tr>
<tr>
<td>18396</td>
<td>20</td>
<td>29</td>
<td>20</td>
<td>29</td>
<td>Global CCS Institute 2017 not linked to Mendeley (Wilfried Macoula, France)</td>
<td>Accepted and addressed</td>
</tr>
<tr>
<td>20249</td>
<td>20</td>
<td>30</td>
<td>20</td>
<td>32</td>
<td>The local museum can provide a space where communities can come together with political leaders and investors on safe ground. (Moritz Reis, Norway)</td>
<td>Noted.</td>
</tr>
<tr>
<td>6751</td>
<td>20</td>
<td>29</td>
<td>20</td>
<td>32</td>
<td>Another important feasibility consideration are the CO2 storage induced earthquakes from large-scale CO2 injection. [<a href="http://www.pnas.org/content/10.1073/pnas.1419183112.full.pdf">http://www.pnas.org/content/10.1073/pnas.1419183112.full.pdf</a>. Also, it just doesn’t work! <a href="http://www.scribd.com/doc/75241918312.full.pdf">http://www.scribd.com/doc/75241918312.full.pdf</a> (Jennifer Morgan, Netherlands)]</td>
<td>Accepted. The first point is an issue on which there is medium agreement; there are a few studies emphasising the earthquake risk but others indicating that it can (and must) be managed. The second would go under geophysical feasibility. The second point is a part of more political feasibility point.</td>
</tr>
<tr>
<td>6393</td>
<td>20</td>
<td>29</td>
<td>20</td>
<td>32</td>
<td>Don't see the point being made in relation to the topic of the paragraph? [Fm Dion, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accepted, sentence removed.</td>
</tr>
<tr>
<td>6750</td>
<td>20</td>
<td>29</td>
<td>20</td>
<td>32</td>
<td>Another important feasibility consideration that isn't mentioned here at all is the scale of the infrastructure that would need to be built. It's enormous. (Wilfried Macoula has written extensively on this. Smi says... &quot;In order to sequence just a fifth of current CO2 emissions we would have to create an entirely new worldwide absorption-gathering-compression-transformation-storage industry whose annual throughput would have to be about 70 percent larger than the annual volume now handled by the global crude oil industry, whose immense infrastructure of wells, pipelines, compressor stations and storage tank gathers energy to build.&quot; [<a href="http://www.scribd.com/doc/75241918312.full.pdf">http://www.scribd.com/doc/75241918312.full.pdf</a> (Jennifer Morgan, Netherlands)]</td>
<td>Accepted, but we need to use more recent literature. When we find it, we will include this.</td>
</tr>
<tr>
<td>10922</td>
<td>20</td>
<td>32</td>
<td>20</td>
<td>34</td>
<td>The CCS technology is already available. Norway for instance is becoming a leader in using and plans to start exploiting CCUS technologies abroad. The Geasnova project, partly run by Norway's state energy company Statoil, involves collecting the CO2 produced by a cement factory, a waste incineration site and a fertilizer factory and transporting it by boat off the west coast of Norway where it would be buried under the sea bed. If all goes according to plan, the first CO2 storage hub could come online in 2022. Its promoters say: Shipped storage avoids the requirement for a pipeline transport network, reducing cost, and opening up CO2 storage to any industry near the sea coast, including industrial clusters like Teesside or Rotterdam, for example. (Yara POKKOSTOVA, France)</td>
<td>Taken into account. Sentence will be removed as it's not really feasibility assessment.</td>
</tr>
<tr>
<td>12691</td>
<td>20</td>
<td>32</td>
<td>20</td>
<td>34</td>
<td>...authorisation for capturing most CO2 release from cement. (Beat Brunner, Switzerland)</td>
<td>Noted. Interesting but no reference provided.</td>
</tr>
<tr>
<td>6795</td>
<td>20</td>
<td>35</td>
<td>20</td>
<td>42</td>
<td>The evaluation of fuels is missing. (Amalfi Jafae-Walati, Italy)</td>
<td>Accepted. The whole section on Aviation and Shipping has been revised taking into account these comments.</td>
</tr>
<tr>
<td>10988</td>
<td>20</td>
<td>35</td>
<td>20</td>
<td>42</td>
<td>Apart from biofuels and energy efficiency, for distances shorter than about 800 km moving to other modes of transport such as high speed trains can contribute to making international travel more sustainable. A possible reference to include is: Jonas Alkonen: The role of high-speed rail in mitigating saving potential attaining cuts of 2/3 of the energy per revenue passenger km. I understand that this result includes a component of growth in activity, but</td>
<td>Accepted. The whole section on Aviation and Shipping has been revised taking into account these comments.</td>
</tr>
<tr>
<td>10857</td>
<td>20</td>
<td>35</td>
<td>20</td>
<td>42</td>
<td>...authorisation for capturing most CO2 release from cement. (Beat Brunner, Switzerland)</td>
<td>Accepted. The whole section on Aviation and Shipping has been revised taking into account these comments.</td>
</tr>
<tr>
<td>6578</td>
<td>20</td>
<td>35</td>
<td>20</td>
<td>42</td>
<td>Consider authorisation of global (cement derived) from growth in flows and transport in this sector should be included in this section. (J. David Tabara, Spain)</td>
<td>Accepted, see comment 6088.</td>
</tr>
<tr>
<td>7523</td>
<td>20</td>
<td>36</td>
<td>20</td>
<td>36</td>
<td>Please consider replacing &quot;is ridiculous&quot; with &quot;has so far been challenging&quot; i.e., and also shortly explain why. (Sjur Christophersen, Norway)</td>
<td>Accepted, see comment 6088.</td>
</tr>
<tr>
<td>6752</td>
<td>20</td>
<td>36</td>
<td>20</td>
<td>42</td>
<td>Issues to mention the recent agreement on reducing aviation emissions. <a href="https://www.icao.int/Newsroom/Pages/Regional-agreement-reached-to-mitigate-international-aviation-emissions.aspx">https://www.icao.int/Newsroom/Pages/Regional-agreement-reached-to-mitigate-international-aviation-emissions.aspx</a> (Jennifer Morgan, Netherlands)</td>
<td>Accepted, see comment 6088.</td>
</tr>
<tr>
<td>7907</td>
<td>20</td>
<td>36</td>
<td>20</td>
<td>42</td>
<td>Any discussion of biofuels needs to reference issues of landuse change and food security. (Wenyat Michael, United States of America)</td>
<td>Accepted, see comment 6088.</td>
</tr>
<tr>
<td>17690</td>
<td>20</td>
<td>37</td>
<td>20</td>
<td>37</td>
<td>Aviation emissions could be reduced by about a third by energy efficiency measures. The IATA roadmap on aviation technologies suggests an energy saving potential attaining cuts of 2/3 of the energy per revenue passenger km. I understand that this result includes a component of growth in activity, but I would recommend not to miss different parameters, focusing separately on a) activity projections, b) shifts, c) efficiency improvements and d) fuel switching. (Perpetuo Cazottes, France)</td>
<td>Accepted, see comment 6088.</td>
</tr>
<tr>
<td>18712</td>
<td>20</td>
<td>38</td>
<td>20</td>
<td>38</td>
<td>Reference needed (Wilfried Macoula, France)</td>
<td>Accepted, see comment 6088.</td>
</tr>
<tr>
<td>7524</td>
<td>20</td>
<td>38</td>
<td>20</td>
<td>38</td>
<td>Consider mentioning that the technology for electric airplanes seems very promising for shorter flights. (Sjur Christophersen, Norway)</td>
<td>Accepted, see comment 6088.</td>
</tr>
<tr>
<td>17694</td>
<td>20</td>
<td>38</td>
<td>20</td>
<td>42</td>
<td>...adopted by new business models and (a) means that the whole timeframe could be enhanced in regions of the world with high emissions in subway and vessel energy at the same time (something that would enable high capacity utilisation rates for electric engines). (Perpetuo Cazottes, France)</td>
<td>Accepted, see comment 6088.</td>
</tr>
</tbody>
</table>

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

929
20 41 20 42
Why are the emissions associated with the creation of aviation fuels from biomass significant? Do it matter where these fuels are grown and how they are transported? Are these fuels best made with imaging, which is not grown in Europe where the fuel is being tested? Does the extra refining of these fuels create more emissions? I think this point needs more clarification since biofuels for aviation is what the EU is looking towards these fuels to reduce GHG in the sector. [Elizabeth Aldrich, United States of America]

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

7025
20 42 20 42
Consider using “the origin of the feedstock” instead of “location”. [Øyvind Christophersen, Norway]

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

10923
20 42
Bio-fuels lifecycle CO2 emissions (fuels used in agriculture for biomass) and use of net for biofuels are two considerable issues for bio-fuels. Short-distance electric plans for distances up to 100 km are expected to reach market by 2027 with economical and security advantages over current planes. The only problem left is long flight and intercontinental flights, where even more battery energy/weight progress is needed to make electricity possible. An alternative fuel would be methanol produced by electricity and consumed in fuel-saving to power electric planes. More research needs to be done in the area, which makes long-distance electrically powered planes unlikely before 2030, but predictable by 2050. [Beat Brunner, Switzerland]

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

1993
20 43 20 43

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

15408
20 43 20 43
Here the reviewer proposes to refer also to the “more electric aircraft” or MEA (Kosen et al., “Moving towards a more electric aircraft”. IEEE Aerospace and Electronic Systems Magazine, Volume: 22, Issue: 3, March 2007.) also to the all-electric aircrafts (Amr S. Ghoneim, Georgia Doulgeri, Riti Singh “Challenges of future aircraft propulsion: A review of distributed propulsion technology and its potential application for the all electric commercial aircraft”. Progress in Aerospace Sciences Volume 47, Issue 3, July 2011, Pages 259-301. Although while MEA is a reality, all-electric planes is not yet that developed. [Francisco Javier Hurtado Albit, Germany]

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

13404
20 44

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

10924
20 44
Around 50% of international shipping is fossil fuels. Replacing fossil fuels with electricity will remove 50% of international shipping, a huge benefit for shipping emissions. International shipping is an important emitter of SO2, but it is also an enormous emitter of SO2 (200 biggest container ships emit same amount of SO2 as all cars of the world (documentary “cargo in face carbon du net”, but there are 6000 large cargo ships and NOx and black carbon (BC). SO2 and BC are not the only problems of shipping. However, new types of fuels are being developed for cargo, and Sweden has found local cargo line fully electric and fully automated. More developments need to be done to solve the cargo problem. But it is also a regulatory one, as some countries without regulations are heaven to international cargos. Electrifying large cargo ports would be a first step to allow ships to get renewable electricity when docked, instead of generating megawatts on-board and polluting portual cities, in addition of emitting unwanted CO2. [Beat Brunner, Switzerland]

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

17388
20 44
There has been substantial research into one carbon trajectories for international shipping along with analysis of maritime renewables, alternative fuels and the potential for substantial CO2 emissions savings from the existing basket of technologies and late stage R&D. The retrofitting and replacement of the world’s 60,000 large vessels is not being held up by technology or alternative operating solutions but more by market and non-market failures and barriers. These include split incentives, regulatory inertia, fuel prices etc. [Bows & Smith (2012) The (low-carbon) shipping forecast: opportunities on the high seas, Carbon Management, 3 (6), 525 - 528. Rehmatulla & Smith (2015) Barriers to energy efficiency in shipping: A triangulated approach to investigate the principal agent problem, Energy Policy, 94, 44-57. [Gavin Althwart, United Kingdom (of Great Britain and Northern Ireland)]

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

17389
20 44
Propulsion alternatives for shipping include a slow move away from Heavy Fuel Oil (HFO) towards distillate fuels and is a lesser degree LNG, with increasing interest in bio-fuels (3rd generation - waste derived), wind propulsion, battery and hydrogen. Renewable Energy Options for Shipping – Technology Brief International Renewable Energy Agency Jan 2015: http://www.irena.org/Documents/Downloads/Publisher/HFSHA_Techn_Brief_RE_for_2050Shipping_2015.pdf [Gavin Althwart, United Kingdom (of Great Britain and Northern Ireland)]

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

17390
20 44
The ENVI study took into account the IMO’s own research which found that shipping GHG emissions are projected to grow by between 50% & 250% by 2050. Shipping could be responsible for upto 17% of global CO2 emissions in 2050 if left unregulated and along with Aviation could amount to 40% of global CO2 emissions. [Gavin Althwart, United Kingdom (of Great Britain and Northern Ireland)]

Accept. The whole section on Aviation and Shipping has been revised taking into account these comments.

11152
20 47 21 29
The section “Options for adapting electricity systems to 1:1 C” could also include options for increasing the flexibility of the power sector (grid development, demand management, storage, flexible renewables, CSP, bioenergy). [Michael Schwerin, Netherlands]

Accept - text revised to address power grid flexibility in SOD.
The section on electricity seems to cover water-related issues only, as if the scope was only about adaptation (?). This section would benefit from a more holistic look at the power system transformation, including production technologies, flexibility, smart grids etc. [Elin Larman, France]

It would be helpful to state (briefly) why reliability is decreasing, e.g. irregular rainfall / droughts? [Alison Smith, United Kingdom (of Great Britain and Northern Ireland)]

There is no discussion of distributed generation with renewables. This has both mitigation and adaptation benefits [e.g. increased resilience to extreme weather events]. [Vineet Mishra, United States of America]

Small errors in comma placement (e.g. after "high penetration wind generation", etc. starting to arrive after nearly perfect grammar to this point. [Christopher Bates, Canada]

Again, no mention here of the pace of change and for battery storage to fundamentally disrupt the energy system. Batteries are being deployed with home systems and along with EVs can create new and interesting demand flexibility options that will lower the cost of transitioning to 100% RE while also accelerating the pace of change at the same time. At the same time, batteries are also being used on the bulk system to provide better balance of renewable energy. [https://www.arl.ethz.ch/en/research/special-interests/gas-energy-portfolio-group/2019_documents/journal%20papers/controls%20and%20storage_2019_Renewables_100%20Sustainable%20Energy%20Reawakening%20.pdf] Also, no mention of R&D into new battery technology that could avoid some of the resource limitation issues. http://www.milkeney.com/business-function/sustainability-and-resource-productivity/your-neighbour-battery-storage-the-new-disruptive-technology-in-the-power-sector [Jennifer Morgan, Netherlands]

It would be helpful to state (briefly) why reliability is decreasing, e.g. irregular rainfall / droughts? [Alison Smith, United Kingdom (of Great Britain and Northern Ireland)]

There is much emphasis on water consuming technologies, but no mention of the possibility to switch to energy sources which do not require these water resources. [Beat Brunner, Switzerland]

As technology is crucial for the food, water and energy management systems to be integrated in a cohesive, integrative and interdependent management planning following the principles of the FEW (Food-Energy-Water) nexus dynamics and the interdependencies of the sectors on each other. FEW management systems should be developed on governance levels and encompass the local situations of individual municipalities and countries to a transversal integrated system. [Yana POPROSTOVA, France]

In addition, it is crucial for the food, water and energy management systems to be integrated in a cohesive, integrative and interdependent management planning following the principles of the FEW (Food-Energy-Water) nexus dynamics and the interdependencies of the sectors on each other. FEW management systems should be developed on governance levels and encompass the local situations of individual municipalities and countries to a transversal integrated system. [Yana POPROSTOVA, France]

Hydro-electricity with dams have also an opportunity to convert flushing into pumping-flushing and use the dams as electricity storage, and depending on size, even as a seasonal storage, allowing for compensation for worst winter month(s) in the northern parts. However a cost-benefit calculation needs to be made, keeping in mind the exponential price decrease of batteries at 16 % per year on $/kWh storage. For large storage where power density is not important, a battery storage advantage over Lithium-ion ones: 1. They are environmentally neutral and safe. 2. They can't catch fire or explode. 3. They allow for full cycling (depletion is not a problem) and a much higher number of cycles. These advantages add major sustainability benefits. These batteries manufactures have a hard time against Li-ion economic competition, but from a scientific environmental and sustainability perspective, thus they could be strategic and should probably be supported by government research funds. [Beat Brunner, Switzerland]

Importantly, salt batteries have several big advantage over Lithium-Ion ones: 1. They are environmentally neutral and safe, 2. They can't catch fire or explode. 3. They allow for full cycling (depletion is not a problem) and a much higher number of cycles. These advantages add major sustainability benefits. These batteries manufacturers have a hard time against Li-ion economic competition, but from a scientific environmental and sustainability perspective, they could be strategic and should probably be supported by government research funds. [Beat Brunner, Switzerland]

Hydro-electricity with dams have also an opportunity to convert flushing into pumping-flushing and use the dams as electricity storage, and depending on size, even as a seasonal storage, allowing for compensation for worst winter month(s) in the northern parts. However a cost-benefit calculation needs to be made, keeping in mind the exponential price decrease of batteries at 16 % per year on $/kWh storage. For large storage where power density is not important, a battery storage advantage over Lithium-ion ones: 1. They are environmentally neutral and safe. 2. They can't catch fire or explode. 3. They allow for full cycling (depletion is not a problem) and a much higher number of cycles. These advantages add major sustainability benefits. These batteries manufactures have a hard time against Li-ion economic competition, but from a scientific environmental and sustainability perspective, they could be strategic and should probably be supported by government research funds. [Beat Brunner, Switzerland]

Do not Quote, Cite, or Distribute Page 60 of 159
The conventional list of options considered overlooks most of the proven and promising early results with perennial polyculture and other natural-systems agriculture (and forestry and grazing approaches) ([Amory Lovins, United States of America] — taken into account — text revised)

Section 4.3.3.2: Prof. John DeCicco (U. Michigan) found in Climatic Change (2016) 138:667-580, DOI 10.1007/s10584-016-1764-4, that much of the literature on biomass energy production's carbon balance reflects a confusion between stocks and flows. Such systems decarbonizes only if the increase the ecosystem's net carbon uptake; most do not. ([Amory Lovins, United States of America] — taken into account — text revised)

Section 4.3.3.2: Prof. John DeCicco (U. Michigan) found in Climatic Change (2016) 138:667-580, DOI 10.1007/s10584-016-1764-4, that much of the literature on biomass energy production's carbon balance reflects a confusion between stocks and flows. Such systems decarbonizes only if the increase the ecosystem's net carbon uptake; most do not. ([Amory Lovins, United States of America] — taken into account — text revised)

= Do Not Quote, Cite, or Distribute Page 61 of 159
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
5122 | 22 | 1 | 22 | 15 | The discussion of food should ensure reference (itself fine) to sufficient "nutrition", food and should consider the need for projections of climate impacts on yields of more diversified foods (The United States of America) | Noted, this disappeared from the text after cuts to accommodate to the number of words
10342 | 22 | 1 | 22 | 3 | This is very simplistic statement, from a relative old paper. Suggest to quote more recent literature and take into account not only production, but also distribution and waste aspects. (Jorga Sera Jose Sanchez, Spain) | Accepted - food wastage is now a new item in the text
15413 | 22 | 3 | 22 | 3 | Alternatively, the reference to cooking stoves or furnaces using solar heat or biomass are alternative for autonomous food processing could come here. Also to grid solar processing (p.e. sun driers). (Francois Javier Hartold Albin, Germany) | Accepted - text revised
12697 | 22 | 3 | 23 | 4 | This is why it is imperative to integrate the management and planning of the food, water and energy systems into a common framework. [Yana POPKOSTOVA, France] | Accepted - text revised
10343 | 22 | 6 | 22 | 8 | Change in nutrient of food due to climate change is certainly a possible issue, but there is little evidence that this can only be attributable to cc and if it will be for a number of crops and in all cultures, I suggest some caution with this statement. [Maria Jose Sanz Sanchez, Spain] | Noted, there is an increasing number of references reporting composition changes in food
9984 | 22 | 7 | 22 | 8 | The most recent study on the impact of elevated CO2 on wheat is by Brooking et al. 2017. Refer to: Brooking, M.G., Hig, P. and Peijen, H. 2017. CO2 induced changes in wheat yield and quality. Agronomy Today: 1-23. (Shripa Shah, IF) | Taken into account - text revised
1462 | 22 | 8 | 22 | 8 | On this point please query this review (not only for protein but also Zn. Fe for instance). Myers et al. 2014. Increasing CO2 threatens human nutrition. [Philippe Roudier, France] | Taken into account - text revised
10344 | 22 | 10 | 22 | 15 | The reduction in yield in some areas yes, but it could be an increase in others.... Please consider all the possibilities. This will change the geographical distribution of some crops, it will be good to include some lines of what this may imply for trade and price. [Maria Jose Sanz Sanchez, Spain] | Taken into account - text revised
1463 | 22 | 11 | 22 | 12 | I am wondering about this kind of sentence ("this could be reduced etc..."). the definition of adaptation strategy is to reduce the impact of future CC, so it seems pretty obvious that adaptation will minimise impacts [Philippe Roudier, France] | Taken into account - text revised
13999 | 22 | 12 | 22 | 13 | Each time the pathways are emphasised as socio-economic, socio-technical or socio-ecological - can these facets be explained upfront, and not need to be repeated throughout the chapter? [Sumetee Pahwa Gajjar, India] | Taken into account - text revised
1454 | 22 | 14 | 22 | 14 | there are actually more than 3 options available, please precise if you are going to study in details 3 of them. [Philippe Roudier, France] | Taken into account - text revised
1455 | 22 | 14 | 22 | 14 | By the way, what about food losses (for ex: Mediterra 2016. Zero Waste in the Mediterranean, FAO/CIHEAM) [Philippe Roudier, France] | Accepted, there is a new item dedicated to food wastage
1456 | 22 | 17 | 22 | 17 | Please use a strict definition of "conservation agriculture" due the one by the PAC ("Conservation agricultural soil disturbance") | Taken into account - text revised
1457 | 22 | 17 | 22 | 17 | you could also refer to agroecology which is more diverse: it includes organic agriculture (less chemical inputs=> less emissions) & knowledge intensive strategies (Van der Zaap, P., 2010. Winter variability, soil nutrient heterogeneity and market volatility – Why sub-Saharan Africa's Green Revolution will be location-specific and knowledge-intensive.) [Philippe Roudier, France] | Taken into account - text revised
10250 | 22 | 17 | 22 | 23 | It is worth mentioning that there is currently a trend for creating "multifunctional forests and value chains" (see: https://ec.europa.eu/eip/agriculture) | Taken into account - text revised
20828 | 22 | 21 | 22 | 23 | On page 27 it says that this section will consider both adaptation and mitigation options, but this section is almost entirely about adaptation - even though agriculture accounts for 25% of emissions. It is only this half-sentence (lines 21-25) the mention mitigation, through an indirect reference to dietary change. I was expecting a clearer statement about the options for mitigation in agriculture, including explicit reference to shifting away from animal produce towards plant-based alternatives, and also reducing emissions from nitrogen fertilizers. | Accepted - text revised
10345 | 22 | 17 | 22 | 35 | There is a very limited information of which practices can be used. CA is mentioned and specifically the reader on non-bleage... this should be better reflected, across many SLM practices that can be used. [Maria Jose Sanz Sanchez, Spain] | Taken into account - text revised
9985 | 22 | 23 | 22 | 25 | Although of immense importance as a low cost climate adaptation strategy agroforestry finds a cursory mention in section 4.3.3.2 on ecosystems and natural resources. [Harold Leffertstra, Norway] | Taken into account - text revised
20828 | 22 | 21 | 22 | 23 | On page 27 it says that this section will consider both adaptation and mitigation options, but this section is almost entirely about adaptation - even though agriculture accounts for 25% of emissions. It is only this half-sentence (lines 21-25) the mention mitigation, through an indirect reference to dietary change. I was expecting a clearer statement about the options for mitigation in agriculture, including explicit reference to shifting away from animal produce towards plant-based alternatives, and also reducing emissions from nitrogen fertilizers. There should also be reference to the fact that soil carbon storage is covered in a later section. [Alison Smith, United Kingdom of Great Britain and Northern Ireland] | Rejected - Mitigation will be dealt with by Chapter 2
1471 | 22 | 28 | 22 | 28 | Topic should read - continued to cover other... [David Reay, United Kingdom of Great Britain and Northern Ireland] | Editorial
1469 | 22 | 29 | 22 | 30 | I agree that CA (with its three pillars) would increase yields in many regions. However it does not mean that it is an adaptation strategy to future CC. You have demonstrated that the added value in the future with CC is larger than the added value right now. [Philippe Roudier, France] | Taken into account - food waste is now assessed in the SCO
12698 | 22 | 31 | 22 | 32 | A campaign promoting less food waste, more sustainable household grocery shopping and cooking practices, as well reduced meat consumption have demonstrated to be effective tool at changing behaviours and inducing more sustainable lifestyle. Such campaigns should be intensified in the developed and replicated in the developing world at school level to introduce a behavioral awareness at an early age. [Yana POPKOSTOVA, France] | Taken into account, food waste is now assessed in the SCO
10494 | 22 | 33 | 22 | 33 | Cost-benefit analysis is not considered in this context. [Philpr Kafuri, Namibia] | Taken into account, food waste is now assessed in the SCO
1480 | 22 | 35 | 22 | 36 | Do you have references for this statement? Because I am not sure that most of the food waste is a production stage (rather elsewhere in the value chain). Please remove this sentence if you do not have various arguments, (Philippe Roudier, France) | Accepted - text revised
5123 | 22 | 38 | 22 | 42 | Can't be said to be the barriers to applying climate information (and perhaps to scaling up conservation agriculture)? This would be particularly valuable, given the factors of feasibility being considered in the special report. i.e. From a social perspective, how does gender impact the feasibility of adopting conservation agriculture? [Tonya Rawe, United States of America] | Accepted, some info was added about climate information
10548 | 22 | 39 | 22 | 41 | There are also cultural and social barriers. [Maria Jose Sanz Sanchez, Spain] | Taken into account - text revised
1462 | 22 | 41 | 22 | 41 | Generally about climate services: note that they are useful not only for agriculture but also health, water management, energy, DRR etc. I think this should be highlighted nice for example the GFCFS website [Philippe Roudier, France] | Taken into account - text revised

Do Not Quote, Cite, or Distribute Page 62 of 159 Page 52 of 159
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
1461 | 22 | 41 | 22 | 42 | You could precise that many African countries are developing their national plans for climate services... | Taken into account - text revised
1940 | 22 | 44 | 22 | 48 | How do these successes relate to the barriers listed in the previous paragraph? [Sumedha Pahwa Gajjar, India] | Taken into account - text revised
10347 | 23 | 1 | 23 | 1 | There is an excessive optimism about the bioengineering. Trade-offs should be better reflected (as farmers depending of seeds firms). [Mano José Sanz Sánchez, Spain] | Taken into account - text revised
1463 | 23 | 1 | 23 | 10 | what about local genetic diversity? As demonstrated by Sultan et al. (2013), the traditional phytopharmacological use are less impacted by CC than the modern improved cultivars (sorghum and millet). [Philippe Rouquier, France] | Rejected - there is no space to deepen to this level
11153 | 23 | 1 | 23 | 18 | This section on genome modification could also mention the need for safeguards for smallholder farmers and careful consideration of the risks. [Michiel Scheweffer, Netherlands] | Taken into account - text revised
18388 | 23 | 2 | 23 | 2 | CRISPRI Cas9 not linked to Mendeley [Elvira Poloczanska, Germany] | editorial
18399 | 23 | 6 | 23 | 6 | Chelleri et al. not linked to Mendeley [Elvira Poloczanska, Germany] | editorial
18402 | 23 | 8 | 23 | 8 | De Groote et al. 2018 not linked to Mendeley [Elvira Poloczanska, Germany] | editorial
2631 | 23 | 12 | 23 | 18 | mention how applicable this is from a feasibility perspective? Eg. in relation to local livelihood, cultures and values, whether it would be more applicable in some regions rather than others [Zohe Shawoo, United Kingdom (of Great Britain and Northern Ireland)] | Rejected - feasibility will be part of another section in the chapter. There will be a table and discussion on that.
19401 | 23 | 12 | 23 | 18 | references for this section are missing - especially those related to precision agriculture, since it is expected to increase efficiency [Sumedha Pahwa Gajjar, India] | editorial
12599 | 23 | 15 | 23 | 15 | In addition, establishing a global, regional and local carbon budgets to the extent possible and adjusting crop selection and growth would be imperative to avoid biomass which creates an unsustainable carbon budget borrowing. [Yana POPSTOZVA, France] | Taken into account - this is in fact not a disadvantage, but a constraint of the method for it to work properly.
14079 | 23 | 18 | 23 | 16 | Address disadvantages of use of genetics and plant transformation for farmers, i.e. loss of control over seeds. [Elvira Poloczanska, Germany] | Taken into account - text revised
10627 | 23 | 18 | | | it would be well worth citing permeability as a way to increase droughtly agricultural yield while lowering need of chemicals. Why higher yield per square meter means less agricultural area needed, which also has a very positive effect on deforestation (for agriculture) and save less dry-ads, with better water retention and evaporative cooling potential. At same time, due to better yield, manual local work is possible and as a result it decreases distances traveled by food, which helps decrease food transportation and distribution as well. [Reid Brunner, Switzerland] | Taken into account - text revised
14125 | 23 | 21 | | | Forestry and ecosystems, maybe using the WGI term and managed ecosystems will capture this section (eg native and plantation forests are included) [Elvira Poloczanska, Germany] | Taken into account - text revised
14124 | 23 | 21 | 23 | 21 | Forests are ecosystems, maybe using the WGI term and managed ecosystems will capture this section (eg native and plantation forests are included) [Elvira Poloczanska, Germany] | Taken into account - text revised
10628 | 23 | 21 | 23 | 41 | Although not emerging or new, sustainable (economically and biologically) forest management is a mitigation option that could safeguard forested areas and shift deforestation. Lack of strict and adequate management plans give way to deforestation often in the tropics [Karen Brando-Briseno, Costa Rica] | Taken into account - text revised
5125 | 23 | 21 | 24 | 36 | Notions of the section are directly related to the preceding section on agriculture, which renders this section on ecosystems and forests less effective in highlighting options in the forest sector. Can the two sections be combined or might a section on land and ecosystems be created that transitions freshwater from agriculture and food to land to forests? [Tonya Rawe, United States of America] | Taken into account - we kept the separation but limited to improve the text and connections.
9622 | 23 | 21 | 23 | 25 | please change the title ‘forest and ecosystem’ to ‘ecosystems and biodiversity’, because forest is also the ecosystem type. This section only describes the adaptation response measures, about what adaptation is to adaptation. There are much more assessments for the adaptation response in chapter 2 in this report, hence much more assessments about adaptation options should be given such as measurements of wetland management or controlling desertification. [Hang Wu, China] | Rejected - we prefer to use Forest and Ecosystems
20546 | 23 | 21 | 23 | 25 | The section should make due reference to decision frameworks that aim to promote integration of climate change adaptation principles into conservation planning by prioritising and targeting relevant actions to increase the adaptive capacity of species, including: Tanner-McAllister eta la. 2017. Managing for desertification,biodiversity conservation for response to climate change. [Jianguo Wu, China] | Noted, references are cited according to the context. There is no space to add more.
3882 | 23 | 22 | 23 | 22 | The carbon stocks and net primary productivity values need citations. Also, say “remedial carbon stock” to be most precise. [Patrick Gonzalez, United States of America] | Taken into account - text revised
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1080</td>
<td>23</td>
<td>22</td>
<td>23</td>
<td>28</td>
<td>This paragraph extends as it is ambiguous. Yes the profitability rate seems to show a decrease but the paper in question has a short time sample and the rates are still on the positive side so it is unlikely offsetting carbon emissions. [<a href="http://www.nature.com/reviews/journal/v15/113/full/nature14283.html?nt%E6%BB%9A%E5%8A%A8%E8%87%B3back-to-top">http://www.nature.com/reviews/journal/v15/113/full/nature14283.html?nt滚动至back-to-top</a>] and <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3038296/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3038296/</a>. As such the rate of sequestration needs to be reconsiged and complemented into the overall estimates by the models. Once forest reach stability, those will be key guarantors of the sequestered dynamic carbon remaining as such. There are two sides to both of these being mixed: one is reducing emissions from D&amp;D. The other one is sequestering emissions sources from other sectors that the remaining forests are doing. Here, only the second one is mentioned but under a &quot;negative&quot; somewhere discretion perspective. This is most worrisome since the amount of emissions sequestered by a no means minimal. [makaka aguie-amarshageuq, United States of America]</td>
<td>Noted, text was modified and shortened and this became out of the context.</td>
</tr>
<tr>
<td>10349</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>24</td>
<td>It will be worth to mention that the Amazon biome is critical for the overall water cycle in the region, not to mention that even the energy mix of Brazil, Paraguay and Argentina we have a heavy share of hydro due to the existance of the Amazon forest, [Maria Jose Sanz Sanchez, Spain]</td>
<td>Noted, the Amazon will be one of the Case Studies in the chapter</td>
</tr>
<tr>
<td>16414</td>
<td>23</td>
<td>25</td>
<td>23</td>
<td>26</td>
<td>I thought there were new papers suggesting that with a modest warming there could be a sharp reduction in the ability of the Amazon to take up carbon as a tipping point. Would not be appropriate to mention this possibility? [Michael MacCracken, United States of America]</td>
<td>Taken into account, the Amazon will be one of the Case Studies in the chapter</td>
</tr>
<tr>
<td>10348</td>
<td>23</td>
<td>25</td>
<td>23</td>
<td>26</td>
<td>The sentence needs a reference. [Maria Jose Sanz Sanchez, Spain]</td>
<td>Noted</td>
</tr>
<tr>
<td>21176</td>
<td>23</td>
<td>26</td>
<td>23</td>
<td>26</td>
<td>note despite some recent reversals, there has been an 80% reduction in the rate of deforestation in the Brazilian Amazon in previous 10 years [David Cooper, Canada]</td>
<td>Taken into account, the Amazon will be one of the Case Studies in the chapter</td>
</tr>
<tr>
<td>14080</td>
<td>23</td>
<td>27</td>
<td>23</td>
<td>27</td>
<td>In section 4.3.3 the statement regarding 85% decrease of deforestation in the Amazon sounds rather optimistic. The language should be coherent and the message of how the trend should be clear. [Bhava Polacharzana, Germany]</td>
<td>Taken into account, the Amazon will be one of the Case Studies in the chapter</td>
</tr>
<tr>
<td>13516</td>
<td>23</td>
<td>31</td>
<td>23</td>
<td>31</td>
<td>The exact meaning of the sentence seems less clear. Please improve [Hans Leflerter, Norway]</td>
<td>Taken into account, text changed</td>
</tr>
<tr>
<td>6658</td>
<td>23</td>
<td>30</td>
<td>23</td>
<td>32</td>
<td>Shallow marine ecosystems capable of accumulating great amount of muddy sediment very not in organic matter (estuaries ecosystems, salmarshes, etc) and strongly affected by warming will also be talked here. [Caecker Munuz Soldins, Spain]</td>
<td>Taken into account, Coastal transitions is assessed</td>
</tr>
<tr>
<td>13520</td>
<td>23</td>
<td>31</td>
<td>23</td>
<td>32</td>
<td>The expression &quot;a considerable proportion of carbon&quot; raises the question of which carbon. Suggest either &quot;a considerable proportion of the Earth's carbon&quot;, or &quot;a considerable amount of carbon&quot; [Hannel Leflerter, Norway]</td>
<td>Taken into account, text changed</td>
</tr>
<tr>
<td>14361</td>
<td>23</td>
<td>33</td>
<td>23</td>
<td>33</td>
<td>Add full stop before &quot;Options&quot; [Evoarea Dakakapourne, Greece]</td>
<td>accepted - text revised</td>
</tr>
<tr>
<td>11192</td>
<td>23</td>
<td>33</td>
<td>23</td>
<td>34</td>
<td>Options such as afforestation and revegetation and CDR. Shallow marine sinks (without) CCO2 should also be included in this bar, as it is a form of land-based mitigation that uses land, unless this section is only focusing on negative emissions [in which case this could be made clearer] [Michael Schoeller, Netherlands]</td>
<td>Taken into account, the Amazon is one of the Case Studies in the chapter</td>
</tr>
<tr>
<td>7954</td>
<td>23</td>
<td>33</td>
<td>23</td>
<td>33</td>
<td>Fully agree. [Jasmin Kemper, United Kingdom of Great Britain and Northern Ireland]</td>
<td>Noted</td>
</tr>
<tr>
<td>14061</td>
<td>23</td>
<td>34</td>
<td>23</td>
<td>34</td>
<td>BECCS has been spelled out before, please the acronym is fine. [Evoarea Dakakapourne, Germany]</td>
<td>Taken into account, text revised</td>
</tr>
<tr>
<td>20337</td>
<td>23</td>
<td>36</td>
<td>23</td>
<td>36</td>
<td>Safeguarding ecosystems and associated biodiversity should be included. [Mario Pretzler, Germany]</td>
<td>Taken into account, text revised</td>
</tr>
<tr>
<td>10300</td>
<td>23</td>
<td>39</td>
<td>23</td>
<td>40</td>
<td>Other complementary approaches... to which one? - Unclear sentence. [Maria Jose Sanz Sanchez, Spain]</td>
<td>Taken into account, text revised</td>
</tr>
<tr>
<td>13521</td>
<td>23</td>
<td>41</td>
<td>23</td>
<td>41</td>
<td>Consider to rewrite the word &quot;directly&quot;, because it can be perceived that they might compete indirectly and in that case how? The end of the sentence &quot;could have substantial co-benefits in terms of raising crop yields seems also to indicate that an eventual interaction will be positive, thus the opposite of competition [Hans Leflerter, Norway]</td>
<td>Taken into account, text revised</td>
</tr>
<tr>
<td>4965</td>
<td>23</td>
<td>44</td>
<td>23</td>
<td>44</td>
<td>Change &quot;GEOCryos&quot; year/ by &quot;GEOCryos&quot; rec [Ivan Redko, Czech Republic]</td>
<td>Accepted - units have been harmonized.</td>
</tr>
<tr>
<td>7816</td>
<td>23</td>
<td>44</td>
<td>23</td>
<td>44</td>
<td>The ARES LULUCF uptake potential of up to 10.5 GtC/Oey by could be updated by the important completion of Gromec et al. due in PRAS in the next few weeks. On p 4-23 line 53, Smith et al. (2007) could be updated with recent and highly favorable experience of range restoration and carbon uptake by intensive rotational grazing. [Ivan Redko, United States of America]</td>
<td>Accepted - Gromec et al. cited in the ecosystems restoration subsection.</td>
</tr>
<tr>
<td>7607</td>
<td>23</td>
<td>44</td>
<td>23</td>
<td>44</td>
<td>The ARES LULUCF uptake potential of up to 10.5 GtC/Oey by could be updated by the important completion of Gromec et al. due in PRAS in the next few weeks. On p 4-23 line 53, Smith et al. (2007) could be updated with recent and highly favorable experience of range restoration and carbon uptake by intensive rotational grazing. [Ivan Redko, United States of America]</td>
<td>Accepted - Gromec et al. cited in the ecosystems restoration subsection.</td>
</tr>
<tr>
<td>4965</td>
<td>23</td>
<td>45</td>
<td>23</td>
<td>45</td>
<td>Change &quot;100 USD IPCCequiv&quot; by &quot;100 USD IPCCeq&quot; [Ivan Redko, Czech Republic]</td>
<td>Accepted - units have been harmonized.</td>
</tr>
<tr>
<td>12702</td>
<td>23</td>
<td>48</td>
<td>23</td>
<td>48</td>
<td>Demand side management cannot simply be ignored as under-researched. Without consideration of the demand-side management measures and how to push for acceleration on this vector, we cannot expectability expect to enter into a 1.5C pathway. This is a substantial omission of the report. [Vane POPKOSTOVA, France]</td>
<td>Noted - However, the text has changed substantially after the FOD and placeholders have been dropped.</td>
</tr>
<tr>
<td>1081</td>
<td>23</td>
<td>48</td>
<td>23</td>
<td>48</td>
<td>Estimates need to be estimated here. Numbers are missing. Once these are in place it is the context of the previous comment need to be addressed. [makaka aguie-amarshageuq, United States of America]</td>
<td>Noted - However, the text has changed substantially after the FOD and placeholders have been dropped.</td>
</tr>
<tr>
<td>10351</td>
<td>23</td>
<td>49</td>
<td>23</td>
<td>49</td>
<td>Numerical value for the percentages are missing [Maria Jose Sanz Sanchez, Spain]</td>
<td>Author</td>
</tr>
<tr>
<td>14407</td>
<td>23</td>
<td>53</td>
<td>23</td>
<td>53</td>
<td>Smith et al. [2007] not linked to Mercadiso [William Mcdonald, Chile, France]</td>
<td>Author</td>
</tr>
</tbody>
</table>
| 19402      | 24        | 2         | 23      | 34      | Please look reference on pontikis (portulaca afra) as a ground cover in arid and semi-arid zones with an even higher potential for carbon sequestration than deciduous forests - Mills, A.J. & Cowling, R.M. 2006. Rate of carbon sequestration at two thicket restoration sites in the Eastern Cape, South Africa. Restoration ecology Vol. 1, No. 1, pp. 38 - 49 [Sumatele Paheza Galje, India] | Rejected, too specific. The text of the chapter had to be shortened
The agroforestry system is promising for diversified landscapes and for biodiversity conservation. In the case of sugarcane, the potential benefits include increased yield, improved soil fertility, and reduced need for chemical inputs. However, it is important to note that the implementation of such systems requires careful planning and management to ensure sustainability.

Noted. There are indeed species that are potentially more productive than sugarcane. However, none have reached the commercial level and the applications in large scale as a bioenergy source as sugarcane did.

Noted. There are indeed species that are potentially more productive than sugarcane. However, none have reached the commercial level and the applications in large scale as a bioenergy source as sugarcane did.
Comment Response


12103
24
23
24
23

Attention should be paid also to policy and civic mentality shift to an integrated FEW management and planning. Promotion of more consciousness on the stockpiles of food waste, energy consumption and water access would induce change from the bottom-up and legitimate top-down initiatives. [Yana Popkostova, France]

10629
24
29
36

In-depth a adaptation strategy that fulfills the human needs of food security but increases carbon stocks as agroforestry systems is more efficient as a M&A than simple economically compensated conservation [Elemer Briceño-Elizondo, Costa Rica]

19403
24
34
24
36

Are there more examples of agroforestry? Is agroforestry an example of complex adaptive systems approach? Some reflection on how the objective of iterative decision-making and evaluation to be achieved. [Sumeeti Pahwa Gajjar, India]

7820
24
36

An end-use (light-duty vehicle) that uses a quarter of the world’s oil and is undergoing radical change merits more than new words about efficiency (weakened by a related effect that most literature finds unimportant) and one sentence about electrification. Lovins (2018) is the latest update on the extraordinary developments in automotive efficiency, electrification, and transformation of business models, all reinforcing each other. In brief, developments synthesized in Lovins et al. (2004), Cramer & Lovins (2004), Lovins & RMI (2011), and Lovins (2015) are now coming rapidly into full flower. They permit profitable and unencumbered automobiles with 2–4x efficiency gains without or 4–8x with electrification. (This is not just theoretical: such vehicles entered the global market in 2013 and drove—en the best car ever had. The 2015-16 electrification history (somewhat cited in 2-18 line 39 to a 2015 source) was dramatic—60% global EV sales growth in 2015. 42% in 2016 when China sold more than the world did in 2014, and far more to come, including the 10x further 2015-20 growth slated in China’s 13th Five Year Plan. One would never guess from lines 34–36’s extremely brief summary that initiatives that are by some measures the world’s two largest—cars and oil—are entering a period of unprecedented disruption. Lovins (2018) also shows from three industry vehicle designs or design studies that the conventional method of analyzing potential automotive efficiency gains (technology-by-technology supply curves) underestimates potential savings’ quantity and overstates their cost, both by >2x. [Arno Lynove, United States of America]

7674
24
36

An end-use (light-duty vehicle) that uses a quarter of the world’s oil and is undergoing radical change merits more than new words about efficiency (weakened by a related effect that most literature finds unimportant) and one sentence about electrification. Lovins (2018) is the latest update on the extraordinary developments in automotive efficiency, electrification, and transformation of business models, all reinforcing each other. In brief, developments synthesized in Lovins et al. (2004), Cramer & Lovins (2004), Lovins & RMI (2011), and Lovins (2015) are now coming rapidly into full flower. They permit profitable and unencumbered automobiles with 2–4x efficiency gains without or 4–8x with electrification. (This is not just theoretical: such vehicles entered the global market in 2013 and drove the best car ever had. The 2015-16 electrification history (somewhat cited in 2-18 line 39 to a 2015 source) was dramatic—60% global EV sales growth in 2015. 42% in 2016 when China sold more than the world did in 2014, and far more to come, including the 10x further 2015-20 growth slated in China’s 13th Five Year Plan. One would never guess from lines 34–36’s extremely brief summary that initiatives that are by some measures the world’s two largest—cars and oil—are entering a period of unprecedented disruption. Lovins (2018) also shows from three industry vehicle designs or design studies that the conventional method of analyzing potential automotive efficiency gains (technology-by-technology supply curves) underestimates potential savings’ quantity and overstates their cost, both by >2x. [Arno Lynove, United States of America]

1305
24
36
41

This recognizes the policy and financing-related complexities of ecological restoration, but initiatives such as the Water Funds advocated by the Nature Conservancy and implemented in South America (and now Africa) may offer a working model that could be scaled up. [Debra Roberts, South Africa]

10680
24
36
39


10404
24
36
42

Why is there no mention of SDG’s here—some of these observations are captured in SDGs, for terrestrial ecosystems for instance. and Degradation Neutrality. Land Degradation and Development. Online First. DOI: 10.1002/ldr.2732. http://onlinelibrary.wiley.com/doi/10.1002/ldr.2732/full

10630
24
36
52

In-depth a adaptation strategy that fulfills the human needs of food security but increases carbon stocks as agroforestry systems is more efficient as a M&A than simple economically compensated conservation [Elemer Briceño-Elizondo, Costa Rica]

20250
24
43
50

There is a need to communicate these successful strategies, globally to give other similar communities knowledge and an awareness of not being alone in meeting the challenges that climate change brings with it. [Merete Reas, Norway]

932
24
45
52

Should any comment be made on how REDD+ projects can sometimes lead to forcibly holding existing tree hostage and threatening to cut them unless they are paid for each tree left standing. [Elizabeth Aldrich, United States of America]

Response: Accepted - text revised to include reference to this research.

Comment: The discussion of REDD+ is well-rounded and includes useful information on the challenges, as well as to some of the other dimensions of feasibility. How might this discussion be adapted for solutions in the agriculture sector? Or can this discussion inform the kind of analysis that is not yet reflected in literature on agriculture solutions (particularly related to ag & mitigation) and carbon sequestration? How might the analysis of REDD+ relate to property rights and structural causes of deforestation, inform identification of research gaps to be flagged later in or other chapters of the report? 

Response: Accepted - text has been re-written.


Response: Accepted - discussion of multiple aspects and implications of REDD+ have been incorporated into the text.

Comment: The issue of tenure security is a major constraint in the successful implementation of REDD+ programs and should be adequately discussed. It is addressed in the sub-sections 4.3.3 and 4.3.4. 

Response: Taken into account - text has been re-written.

Comment: It is quite worrying that only negative aspects are highlighted. REDD+ is a process that lead a far number of countries to take seriously the protection of their forests, due to all the challenges are now seen and can be addressed. It is not fair to only mention the bad, and forget about the good. The message that this paragraph send is quite unbalance and do not reflect at all the efforts made. But rather discourage to continue and strengthen the process. 

Response: Accepted - discussion of multiple aspects and implications of REDD+ have been incorporated into the text.

Comment: Controversial - need to present other perspectives here. Although the text is theoretically true, the way in which REDD+ has been implemented to date has not optimised adaptation - and perhaps not even development. The Africa chapter in AR5 (Wang et al. 2014) could be a starting point. 

Response: Taken into account - a more balanced approach to discussing REDD+’s relationship to adaptation has been adopted in the SOD.

Comment: 10352. 25 1 25 9 It is quite worrying that only negative aspects are highlighted. REDD+ is a process that lead a far number of countries to take seriously the protection of their forests, due to all the challenges are now seen and can be addressed. It is not fair to only mention the bad, and forget about the good. The message that this paragraph send is quite unbalance and do not reflect at all the efforts made. But rather discourage to continue and strengthen the process. 

Response: Accepted - discussion of multiple aspects and implications of REDD+ have been incorporated into the text.


Response: Taken into account - text has been re-written.

Comment: The value of urban green infrastructure has recently been highlighted in the following World Bank Report: Letley, 2017. “Greening Africa’s Cities: Enhancing The relationship between urbanization, environmental assets and ecosystemservices.” World Bank, Washington, DC. 

Response: Agreed. Findings added in the form of new text in 4.3.4.

Comment: Also important to note that many cities in the global south do not only have the more traditional urban green spaces within their borders, but large areas of suburban landscapes which has an important role in increasing adaptive capacity e.g. Roberts, D., Stoor R., Dickenson, N., Dossers, E., Goonerat, N., McNicoll, A., McCraken, C. D. Oronogh, S., and Spies, M. (2012). Exploring ecosystem-based adaptation in Durban, South Africa: Learning-by-doing’ at the local government cost face. Environment and Urbanization, 24 (1): 167-195. 

Response: Agreed. Findings added in the form of new text in 4.3.4.

Comment: Also important to note that many cities in the global south do not only have the more traditional urban green spaces within their borders, but large areas of suburban landscapes which has an important role in increasing adaptive capacity e.g. Roberts, D., Stoor R., Dickenson, N., Dossers, E., Goonerat, N., McNicoll, A., McCraken, C. D. Oronogh, S., and Spies, M. (2012). Exploring ecosystem-based adaptation in Durban, South Africa: Learning-by-doing’ at the local government cost face. Environment and Urbanization, 24 (1): 167-195. 

Response: Agreed. Findings added in the form of new text in 4.3.4.


Response: Taken into account - text has been re-written.


Response: Taken into account - text has been re-written.


Response: Accepted. General findings included.

Comment: The section on Urban green cover (4.3.3) summarises well some of the key challenges, but does not seem to capture the significant interplay between the urban scale of growth and pressures of urbanization and need to preserve / develop green cover, which in many urban development models is in conflict. The green of urban green spaces may well lead to ‘concern over their governance’, but this is within the complex governance context of the city as a planned / unplanned growing system. (Pg 25: the 54 to Pg 28 the 6 address this obliquely). 

Response: Taken into account - text revised.

Comment: Urban green land may be option for adaptation and mitigation of climate change, pollution controlling. 

Response: Taken into account - text revised.

Comment: The section on Urban green cover (4.3.3) summarises well some of the key challenges, but does not seem to capture the significant interplay between the urban scale of growth and pressures of urbanization and need to preserve / develop green cover, which in many urban development models is in conflict. The green of urban green spaces may well lead to ‘concern over their governance’, but this is within the complex governance context of the city as a planned / unplanned growing system. (Pg 25: the 54 to Pg 28 the 6 address this obliquely). 

Response: Taken into account - text revised.

Comment: The section on Urban green cover (4.3.3) summarises well some of the key challenges, but does not seem to capture the significant interplay between the urban scale of growth and pressures of urbanization and need to preserve / develop green cover, which in many urban development models is in conflict. The green of urban green spaces may well lead to ‘concern over their governance’, but this is within the complex governance context of the city as a planned / unplanned growing system. (Pg 25: the 54 to Pg 28 the 6 address this obliquely). 

Response: Taken into account - text revised.

Comment: The section on Urban green cover (4.3.3) summarises well some of the key challenges, but does not seem to capture the significant interplay between the urban scale of growth and pressures of urbanization and need to preserve / develop green cover, which in many urban development models is in conflict. The green of urban green spaces may well lead to ‘concern over their governance’, but this is within the complex governance context of the city as a planned / unplanned growing system. (Pg 25: the 54 to Pg 28 the 6 address this obliquely). 

Response: Taken into account - text revised.

Comment: The section on Urban green cover (4.3.3) summarises well some of the key challenges, but does not seem to capture the significant interplay between the urban scale of growth and pressures of urbanization and need to preserve / develop green cover, which in many urban development models is in conflict. The green of urban green spaces may well lead to ‘concern over their governance’, but this is within the complex governance context of the city as a planned / unplanned growing system. (Pg 25: the 54 to Pg 28 the 6 address this obliquely). 

Response: Taken into account - text revised.

Comment: The section on Urban green cover (4.3.3) summarises well some of the key challenges, but does not seem to capture the significant interplay between the urban scale of growth and pressures of urbanization and need to preserve / develop green cover, which in many urban development models is in conflict. The green of urban green spaces may well lead to ‘concern over their governance’, but this is within the complex governance context of the city as a planned / unplanned growing system. (Pg 25: the 54 to Pg 28 the 6 address this obliquely). 

Response: Taken into account - text revised.

Comment: The section on Urban green cover (4.3.3) summarises well some of the key challenges, but does not seem to capture the significant interplay between the urban scale of growth and pressures of urbanization and need to preserve / develop green cover, which in many urban development models is in conflict. The green of urban green spaces may well lead to ‘concern over their governance’, but this is within the complex governance context of the city as a planned / unplanned growing system. (Pg 25: the 54 to Pg 28 the 6 address this obliquely). 

Response: Taken into account - text revised.

Comment: The section on Urban green cover (4.3.3) summarises well some of the key challenges, but does not seem to capture the significant interplay between the urban scale of growth and pressures of urbanization and need to preserve / develop green cover, which in many urban development models is in conflict. The green of urban green spaces may well lead to ‘concern over their governance’, but this is within the complex governance context of the city as a planned / unplanned growing system. (Pg 25: the 54 to Pg 28 the 6 address this obliquely). 

Response: Taken into account - text revised.

19406 25 13 25 37 There are several additional publications on this topic in relation to cities and locations across the world, some of which can be found on the TDIC. Dagmar Haase et al (2017), Emplot et al (2016) among others. References are somewhat limited. [Suresh Anand Gajar, India] Taken into account - text revised.

20829 25 13 25 37 This section would benefit from a cleaner and more comprehensive list of the multiple benefits of urban green infrastructure. Adaptation benefits include: flood protection, stormwater management, improved water infiltration, local cooling and shading, mitigation benefits from carbon sequestration and in vegetation and soils. Co-benefits include a range of other ecosystem services - not just pollution and urban food production, but also: improved air and water quality, and cultural/economic services including aesthetic value, opportunities for recreation, education about nature, interaction with wildlife, and a ‘sense of place’ (local identity). The section on ‘active’ and ‘passive’ benefits needs to explain what these terms mean in this context, e.g. by ‘passive’ do you mean the benefits of seeing nature (i.e. aesthetic value), and by ‘active’ do you mean physical recreation? The whole section also overlaps with section 4.3.4.1.2 (Abson Smith, United Kingdom of Great Britain and Northern Ireland) Accepted - text revised.

15402 25 14 25 14 Green et al., 2016 not linked to Mendeley (Wilfran Moufouma Okia, France) Accepted - text revised.

2790 25 15 26 45 Widespread adoption of atomic weapons could have a significant impact. Fewer vehicles would be needed and much less land would need to be devoted to parking, thus facilitating denser development. Sorry I don't have a reference for this. Also relevant for p. 29, 17 to 25. [Eric Hakle, Canada] Accepted - text revised.

9339 25 16 25 16 The reference “Bird et al (2016)” may be provided in parenthesis since it is not used within the sentence structure [Siir KILKIS, Turkey] editorial.


1000 25 17 26 45 Add the words “along with cool roofs and pavements” before “reduction of urban heat islands” [Stephen Wind, United States of America] Taken into account - text revised.

14126 25 17 25 17 It is not clear what pollution of numerous areas means as it is currently worded [Elina Polkanetskaia, Germany] Taken into account - text revised.

14903 25 18 25 19 References not linked to Mendeley (Wilfran Moufouma Okia, France) Accepted - text revised.

18404 25 22 25 22 Lin et al, 2018 not linked to Mendeley (Wilfran Moufouma Okia, France) editorial.

1393 25 22 25 24 The statement that urban dwellers will benefit more from passive measures needs to be better explained: for example by citing the principle of the “leading edge effect” [Sporron-Smith, R. A., T. R. Oke, and W. P. Lowry (2000), “Advection and the Surface Energy Balance Across an Irrigated Urban Park?” (Cambridge, United States of America)] Accepted and text amended to reflect risks and opportunities Global South cities


4818 25 37 25 37 Lin et al, 2018 not linked to Mendeley (Wilfran Moufouma Okia, France) editorial.

9625 25 40 26 40 Add the context there are only title, [Cengiz Wv. CITLAW] Accepted - text revised.

4892 25 43 25 30 Waste management is generally harder covered in section 4.3. Although there are close links to greenhouse gas emissions (sustainable waste management is key to reducing GHG emissions, see earlier comment to Chapter 2). Here in this section 4.3.4. Urban infrastructure and industrial transitions, a new subsection ‘Waste Management and Circular Economy’ should be introduced. Alternatively, waste management could be discussed as part of section 4.3.4.3 Sustainable Water and Environmental Services, and then the topic of circular economy could be expanded in section 4.3.4.3 ‘Industrial Transitions’ (Sigurd Kruis, Germany). [Stewart Lockie, Australia] Accepted and text amended to reflect risks and opportunities Global South cities

11466 25 43 25 42 While there is some consideration of poverty and equity in Section 4.3.4.3 it is largely confined to landslide risk reduction and food provisioning. The section does not explore the potential benefits from tourism. The development of the developed world as the norm and posits inequality as the baseline to which the urban developing world is compared. This is not consistent with the main theme of the chapter. Among other challenges, cities in the world’s tropics face the twin prospects of rapid population growth and the need to adapt to climate states with no present day analogues. A 1.5 degree world poses many more questions for Kinshasa or Manilla than it does for most cities in Europe or North America. *See the State of the Tropics 2014 report at stateofthetropics.org* [Sigurd Kruis, Germany] Accepted and text amended to reflect risks and opportunities Global South cities

1914 25 43 25 43 My general impression is that Section 4 is still rather the least of the four chapters. For instance statements like “will be defined for four critical elements” need restating in more general terms. [Siir KILKIS, Turkey] Accepted - Section being revisited and substantially revised.

9274 25 45 25 51 Check Gratiosa et al., 2016 (In Press) and Rosenzweig et al., 2015 [Jorinda Rosenzweig, United States of America] Accepted. Rosenzweig cited (will look out for Gratiosa) in substantially revised text.

14316 25 51 26 52 The United Nations (UN) is a great example of supra-national governments who cross social, regional, national and institutional boundaries to facilitate conflict resolution and bring different stakeholders to the table, [Jasmin Huchard, Switzerland] Accepted - text revised.

11485 25 52 25 68 There are some big gaps in this paragraph that do not bear scrutiny. The claim that what happens in cities and other urban centres will be greater is true, the influence on climate change is highly contestible and completely unnecessary. We do not need to argue that land-use change, deforestation, energy production etc. are either less important than or, in some way subgroup to ‘the city’. The claim that local government will be the key driver of global ambition is just as contestible and unnecessary. The paragraph as a whole should be stripped of jargon. [Stewart Lockie, Australia] Taken into account. Waste management will be included in 4.3.3. A separate section on industry will be created (the new 4.3.5) that will include circularity. Note that only new literature relative to AR5 will be discussed; AR5 had a significant discussion of waste management. Accepted - text revised.

10529 25 3 41 All mitigation techniques should be discussed including the trade-offs, side-effects and impacts on human and natural systems. A starting point may be: Key impacts of climate engineering on biodiversity and ecosystems, with priorities for future research [Alison Smith, United Kingdom (of Great Britain and Northern Ireland)] Taken into account. The mitigation options are assessed for feasibility in the six categories introduced in 4.3.1, which include the issues mentioned. Thank you for your reference; we will explore whether it adds value to the assessment to include it.

Do Not Quote, Cite, or Distribute Page 68 of 159
The statement “A new type of urban culture will be desirable that bridges disciplinary boundaries and practices a mix of approaches to create an evidence base for action” (Scolato et al., 2013) may include an emphasis on the emerging role of composite indicators for supporting the “science of cities.” Composite indicators are particularly well suited to address multi-disciplinary complex issues. One such example is the Sustainable Development of Energy, Water and Environment Systems (SDEWES) Index that has been developed as a composite indicator based on 7 dimensions and 35 indicators to trigger policy learning, action, and cooperation to bring cities closer to sustainable development. The SDEWES Index has been applied to 120 cities around the world and may be an example of an information box that will be equally provided by the Reviewer in support of indicator based evidence-based supporting urban action. References for the SDEWES Index are cited in the IPCC WGI SR15. A Comprehensive index for benchmarking local energy systems. https://doi.org/10.1016/j.energy.2015.08.039. 

17696 26 11 27 55

Transportation infrastructure is just part of the built environment, and policies aimed at its development-modification (such as the choice to support high capacity urban rail more than roads) may have major impacts on the energy intensity of mobility in cities. This is not covered at all in this section.

[Perpsecta Cazalia, France]

19728 26 11

section on urban areas. This section needs to discuss the importance of the right to participation in urban planning. [Tara Shive, Ireland]

Accepted and participation in urban planning now included. Rights frameworks and the right to participation addressed under “enabling environment”.

[Perpsecta Cazalia, France]

9033 26 11 27 55

Currently, huge amount of energy (GHG) is inefficiently used by energy generation and consumption facilities such as buildings, industrial plants. Many of energy intensive appliances can be operated more energy efficient manner by regular monitoring of performance, peakpoint analysis, energy efficiency control of the facilities. [Hung, Qu.Kim, Republic of Korea]

Accepted. Energy efficiency of buildings and appliances included in revised text.

9275 26 15


Taken into account. But that particular reference is not included.

17695 26 15 26 45

I think that this whole section should open up to integrate important considerations on the opportunities that may be associated with the ICT-enabled concept of “mobility as a service”. This is something that may strengthen high capacity public transport systems, especially in regions where their economic viability is limited today, thanks to the provision of feeder services. This is also the place to bring up important points on the impacts posed by “mobility as a service”. For example, it is necessary to underline the need for policy to ensure that “mobility as a service” is effectively coupled with electrification. Given the importance of autonomous driving and the likely upward impact on transport activity (due to lower costs a likely lower value of time loss, likely to lead to greater travel times and distances), as well as the risk for upward impacts on travel demand if autonomous driving interferes the concept of “mobility as a service”, this is also the place where you should be underlining the relevance of policies aiming at maintaining urban structure compact as a way to counterbalance the likely increasing push towards sprawl driven by the development of these technologies. [Perpsecta Cazalia, France]

Noted. ICT, technology and ICT included in revised section. Transport section also notified of this comment.

14082 26 16 20 21

This is a really long sentence, not sure by the end what it is that it promotes diversity and vitality – suggest breaking down into shorter sentences. [Enira Polymaritsa, Germany]

Editorial.

14362 26 16 20 21


Noted. Not clear that forest land management belongs in this urban section.

20830 26 16 20 25

This paragraph contains several important points but they are not clearly explained. It should be good to make it clearer that: compact development and mixed land-use (housing close to employment, schools, etc) help to reduce total demand for travel and create the opportunity for increased active travel (walking and cycling) ii) this provides benefits for health from increased physical activity (Miller et al.), and also reduces air pollution, noise, congestion and accidents, as well as improving opportunities for social interaction. The ref used by Puppim de Oliveira does not refer to climate adaptation - it deals with public transport, waste management and industrial emissions. It is not clear how mixed land use can contribute to resource use efficiency - if this refers to reduced transport fuel demand, for example, then this should be clearly stated. The last sentence appears to have a word missing as it does not make sense. [Alison Smith, United Kingdom (of Great Britain and Northern Ireland)]

Editorial. De Oliveira ref removed in revised text.

7910 26 16 20 46

There is a whole body of work coming out of the New Climate Economy project that shows the benefit of compact urban development (http://www.coalitionforurbantransitions.org/home/publications-and-resources). Ahlfeldt and Piertostefani (“Demystifying Compact Urban growth”) have There is also evidence that a mixed-objective land management in Mediterranean forests and rangelands contributes to their resilience. [Riis, M.J., Bakoer, J., Bauletta, S., Christoforou, M., Dakolopoulos, I.N., Hadjimitsis, D., Keizer, J.J., Lingen, H., Quarto, G., Ribbeo, C., Salare, R., Thiene, I.R., Urrughe, A., Valdecantos, A., Schielch, G., 2017. How does land management contribute to the resilience of Mediterranean forests and rangelands? A participatory assessment. Land Degradation & Development (accepted). [Ioannis Daliakopoulos, Greece]

Noted. Not clear that forest land management belongs in this urban section.

7011 26 16 25


Noted. Some of this work has been cited in Chapter 4. The sections of the work that are published are already being considered for inclusion, as “grey literature”.

7819 26 23 26 25

Peter Calthorpe—surprisingly absent from the discussion, since he is implementing new urbanist design in U.S. cities—has just posted at https://www.wired.com/2016/09/peter-calthorpe_calthorpe_7_principles_for_building_dendrites微信公众平台_201422 a TED talk neatly encapsulating the principles of sustainable urban form and design. I don’t know if he has published them more formally. [Amory Lovins, United States of America]

Accepted. Included a reference to Calthorpe 2010. Ideally we would have more recent peer reviewed literature.
Comment

I suggest the following amendment: A range of studies have shown how oil-based greenhouse gas emissions are associated with high-density, mixed-use walking city urban fabric are much lower than in a medium-density, partially mixed transit city urban fabric and these are much lower than low-density, highly zone automobile urban fabric (Eargy et al. 2016; Newmann et al. 2016). However, the effectiveness of these urban adaptation options can be constrained by planning decisions made across spatial scales (Georgescu et al. 2015), and judicial analysis of changes in urban form or fabric must be considered before these strategies are applied. [Winston Chow, Singapore]

Response

Taken into account and combined with edits regarding multi-level governance and enabling environment.
The analysis/horizon to be rather short-term oriented. Barrington-Leigh and Millard-Bell have argued that for long term climate policy, the road networks laid down during initial construction of new residential developments are immutable and affect emissions, somewhat irreversibly, for centuries. Therefore drastic urgent policy action may be needed in such areas where the pay-off is gradual, but the opportunity only exists in the short-term (during the current, then future phases of the one-time process of urbanization). Overall, more of an introductory framing about the built environment of our cities having complex impacts on energy and emissions, and on different aspects of that built environment being changeable on different time frames, would be useful. See: Barrington-Leigh, C. P., and Adam Millard-Bell, “A Century of Sprawl in the United States,” Proceedings of the National Academy of Sciences, doi:10.1073/pnas.1014033113, 15 June 2015; and Barrington-Leigh, C. P., and Adam Millard-Bell, “More connected urban roads reduce US GHG Emissions,” Environmental Research Letters, doi:10.1088/1748-9326/10/6/064017 (2015). Taken into account and the citations reviewed but not included as part of significantly revised text.
When discussing resilient urban energy systems, two key topics should be added: 1) decentralized urban energy schemes, and 2) community-based. What about zero-energy or even energy-producing buildings? [Arnulf Jaeger-Waldau, Italy] Taken into account in revised text.

The reviewer proposes the insertion of this paragraph: Several consequences emanate from these impacts in the construction and housing sector. The use of thermal insulation technologies with adaptation potential with a view in the developing countries will have to be fostered, for instance the use of locally available building materials. Roofing that reduce energy consumption but contribute to adaptation (roof gardens, coverings with high solar reflectance), or light dependent control systems for sun shading will become even more important. Finally, passive climatization of buildings, use of solar thermal or waste energy and absorption or adsorption systems may play a relevant role. [Alternately or simultaneously] the same paragraph could be inserted in Chapter 5, page 19, line 28, in a more condensed version (commensurate with the level of detail in 5.4.1.1). This possibility has been proposed for chapter 5. [Francisco Javier Hurtado Albir, Germany] Accepted in revised text.

<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>7102</td>
<td>27</td>
<td>35</td>
<td>36</td>
<td></td>
<td>on &quot;Youth&quot;, demands for building repair will change not only due to the increase of extreme weather events, but also to consistent changes in the long-term. In particular, the increased precipitation in Scandinavia will systematically cause more problems in attics (VM Nils, AS Kalgård/P, E)</td>
<td>Taken into account in revised text.</td>
</tr>
<tr>
<td>15413</td>
<td>27</td>
<td>39</td>
<td>40</td>
<td></td>
<td>Under &quot;urban built environment&quot; it would be interesting to introduce a reference to the use of local available building materials - of negligent origin (e.g. that-throw-or-alt), or animal origin (e.g. wool or fur), or stones or minerals (e.g. used trees). Reference for this aspect: J.C. Menees, A. Medeza, M. Oggero, P. Walker: &quot;Building houses with local materials: means to drastically reduce the environmental impact of construction&quot;. Building and Environment, Volume 56, Issue 10, December 2010, Pages 1195-1208 [Francisco Javier Hurtado Albir, Germany]</td>
<td>Taken into account in section on &quot;enabling environment&quot;</td>
</tr>
<tr>
<td>15414</td>
<td>27</td>
<td>47</td>
<td>48</td>
<td></td>
<td>Under &quot;urban built environment&quot; it would be interesting to introduce a reference to the use of local available building materials - of negligent origin (e.g. that-throw-or-alt), or animal origin (e.g. wool or fur), or stones or minerals (e.g. used trees). Reference for this aspect: J.C. Menees, A. Medeza, M. Oggero, P. Walker: &quot;Building houses with local materials: means to drastically reduce the environmental impact of construction&quot;. Building and Environment, Volume 56, Issue 10, December 2010, Pages 1195-1208 [Francisco Javier Hurtado Albir, Germany]</td>
<td>Taken into account in revised text.</td>
</tr>
<tr>
<td>5768</td>
<td>27</td>
<td>50</td>
<td>51</td>
<td></td>
<td>What about zero-energy or even energy-producing buildings? [Arnulf Jaeger-Waldau, Italy]</td>
<td>Taken into account in revised text.</td>
</tr>
<tr>
<td>20322</td>
<td>27</td>
<td>52</td>
<td></td>
<td></td>
<td>The city council mentioned distributed renewables as critical for cities. They have mitigation and adaptation benefits and also can help with issues of energy (SDG #7). These facts were mentioned as well as the benefits of renewable energy for cities have been seen in [Westphal et al. 2017. Powering Cities in the Global South: How Energy Access for All Benefits the Economy and the Environment. World Resources Institute [Westphal Michael, United States of America]</td>
<td>Accepted and text revised.</td>
</tr>
<tr>
<td>4985</td>
<td>27</td>
<td>55</td>
<td></td>
<td></td>
<td>“Energy resilience” of urban energy systems is of key topics which should be added: 1) decentralized urban energy schemes, and 2) community-based energy schemes. [Sigfrid Kusch, Germany]</td>
<td>Taken into account in revised text.</td>
</tr>
<tr>
<td>7327</td>
<td>27</td>
<td>56</td>
<td>57</td>
<td></td>
<td>Delete the text &quot;The heavy dependence of the urban economy, infrastructure, services and residents on electricity and fossil fuels means far-reaching consequences, if supplies are unreliable or disrupted, as has been demonstrated in extreme events (ICF 2012, [Eleni Kaditi, Austria]</td>
<td>Rejected on the basis of the cited literature. But this section has been revised in ways that don't detract from this message.</td>
</tr>
<tr>
<td>7912</td>
<td>27</td>
<td>55</td>
<td></td>
<td></td>
<td>The section could mention distributed renewables as critical for cities. They have mitigation and adaptation benefits and also can help with issues of energy (SDG #7). See Westphal et al. 2017. Powering Cities in the Global South: How Energy Access for All Benefits the Economy and the Environment. World Resources Institute [Westphal Michael, United States of America]</td>
<td>Accepted - not revised to include discussion of distributed renewables.</td>
</tr>
<tr>
<td>1695</td>
<td>27</td>
<td>56</td>
<td></td>
<td></td>
<td>Positive Energy zero-emissions buildings in cities can be seen as building their own energy and lower their energy demand to the grid massively in winter time and have a positive impact on the electric grid overall. In some cities in Canada and France it is mandatory that new buildings are net power energy positive (net to be found). Through such stringent building regulations, corresponding to current technical state, cities can become mostly self-sustainable and resilient to long power outages. Such buildings require good thermal insulation, high-efficiency equipment and solar PV systems on roofs and facades. Esthetic colored solar panels are now available and can be architecturally well integrated into urban buildings, making them very resilient. [Isaak Bunneman, Switzerland]</td>
<td>Accepted. Reference to the importance of building design in the energy balance included in revised text.</td>
</tr>
<tr>
<td>Comment No</td>
<td>From Page</td>
<td>From Line</td>
<td>To Page</td>
<td>To Line</td>
<td>Comment</td>
<td>Response</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-----------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>9281</td>
<td>28</td>
<td>3</td>
<td>3</td>
<td>11</td>
<td>Add information from Mehrotra et al., 2019 (in press) [Cynthia Rosenzweig, United States of America]</td>
<td>Taken into account. Citation will be considered once out.</td>
</tr>
<tr>
<td>9341</td>
<td>28</td>
<td>3</td>
<td>28</td>
<td>11</td>
<td>The indicators of the European Climate Adaptation Platform and the adaptation indicators of Sustainable Energy and Climate Action Plans (SECAP) include “Length of transport network (e.g. road/land) located in areas at risk (e.g. flood/through/heat/wave/flood/forest or land fire)” that may be represented in the following paragraphs. Other sector-oriented indicators as well as indicators of the European Climate Adaptation Platform may also be integrated into the text. [Sirez, KJK, Kyrgyz Republic]</td>
<td>Taken into account. The indicators will be reviewed as we compile our MCE in revised text.</td>
</tr>
<tr>
<td>2372</td>
<td>28</td>
<td>3</td>
<td>28</td>
<td>3</td>
<td>Sustainable and Resilient Transport systems, in this instance and all other instances in this report surely it should be “Resilient and Sustainable…”</td>
<td>Editorial.</td>
</tr>
<tr>
<td>19409</td>
<td>28</td>
<td>3</td>
<td>28</td>
<td>36</td>
<td>The section says very little about why the urban design solutions which were recommended for reducing emissions from transport systems have not translated into a changed urban form. And how certain strategies or solutions contrast others. For example, greater efficiency and engine performance technologies may encourage longer travel times etc. [Suresh Patera, Gajjar, India]</td>
<td>Taken into account in revised text.</td>
</tr>
<tr>
<td>20104</td>
<td>28</td>
<td>3</td>
<td>29</td>
<td>32</td>
<td>The section should be more clear on the role of biotanks in global landgrabbing processes, in the displacement of local and indigenous communities, on the associated human rights issues and detrimental impacts on biodiversity and ecosystem integrity of large-scale biomass plantations for biofuels. The organization Biofuelwatch has published extensively and critically on these issues. Biofuelwatch.org.uk [All Pfeifer, Germany]</td>
<td>Taken into account in the section on BECs and their implications for land and land markets. If you have reviewed literature please forward it.</td>
</tr>
<tr>
<td>7818</td>
<td>28</td>
<td>3</td>
<td>28</td>
<td>40</td>
<td>A major May 2017 publication by India’s strategic planning agency NITI Aayog and Rocky Mountain Institute (India Leaps Ahead, <a href="http://mit.gov.in/lewdeawala/file/document_publication/RMI_India_Report_web.pdf">http://mit.gov.in/lewdeawala/file/document_publication/RMI_India_Report_web.pdf</a>) was announced by NITI Aayog’s CEO Arvind Krishna (reporting directly to Prime Minister Modi, who chairs the agency) as the policy of the Government of India. It lays out a highly progressive and substantive mobility policy, in line with some remarkable institutional and technical innovations of global significance. Almost daily headlines announce the Indian private sector’s ambitious plans to carry it out. It should be mentioned here. [Arvind Loonan, United States of America]</td>
<td>Taken into account in revised text. Note the need to reflect realities from developing and developed country contexts - and the combined rapid rise in (classic) car ownership in developing countries, with only isolated leap-frogging.</td>
</tr>
<tr>
<td>7672</td>
<td>28</td>
<td>3</td>
<td>28</td>
<td>40</td>
<td>A major May 2017 publication by India’s strategic planning agency NITI Aayog and Rocky Mountain Institute (India Leaps Ahead, <a href="http://mit.gov.in/lewdeawala/file/document_publication/RMI_India_Report_web.pdf">http://mit.gov.in/lewdeawala/file/document_publication/RMI_India_Report_web.pdf</a>) was announced by NITI Aayog’s CEO ArvindKrishna (reporting directly to Prime Minister Modi, who chairs the agency) as the policy of the Government of India. It lays out a highly progressive and substantive mobility policy, in line with some remarkable institutional and technical innovations of global significance. Almost daily headlines announce the Indian private sector’s ambitious plans to carry it out. It should be mentioned here. [Arvind Loonan, United States of America]</td>
<td>Taken into account in substantially revised text.</td>
</tr>
<tr>
<td>10868</td>
<td>28</td>
<td>3</td>
<td>29</td>
<td>32</td>
<td>A major gap in this section appears to be the possibility of disruption and transformation due to technological change. Currently, a backward-looking perspective dominates. For this to be useful, a backcasting (goal-driven and implementation-oriented) perspective to planning must dominate the predict and predict-fail narrative. In particular, I am thinking about the disruption by driverless cars as an example. They could reverse “peak car”, could radically impact urban sprawl, and reverse the reversal in street network sprawl documented by Barrington-Leigh and Millard-Ball, PMAS 2015, and will certainly make congestion charging and parking charges mandatory. That is, they represent a huge change in incentives. How do they work into this in SR15? The same way every city already is making slow that migration requires talking about it. Imagine what we will be like with 30% of urban space freed up from parking, imagine what new restrictions will need to be in place to keep emissions-intensive behaviours down, etc., in general, please look forward as much as possible, giving a sense that boldness and creativity and imagination and future-thinking and experimentation will be needed, not 20-year-old applications. Driverless cars are mentioned much later, in 4.4.2.3, as though they are a speculative possibility. This is not in line with decisions planners face and are faced with today. It seems policy must be much more proactive to reduce the “rebound effects” mentioned there (suggestively, reactively?) [Barrington-Leigh, Christopher, Canada]</td>
<td>Taken into account in revised text. Note the need to reflect realities from developing and developed country contexts - and the combined rapid rise in (classic) car ownership in developing countries, with only isolated leap-frogging.</td>
</tr>
<tr>
<td>7913</td>
<td>28</td>
<td>4</td>
<td>28</td>
<td>38</td>
<td>The section does not reference recent work (BNIF) that shows the EVs being competitive with ICEs in most regions in the 2020s, but does not mention all of the new policy commitments for phasing out ICEs. In addition, the possible impacts of AVs on congestion and emissions should be mentioned. [Westphal Michael, United States of America]</td>
<td>Accepted. Future commitments now mentioned.</td>
</tr>
<tr>
<td>2791</td>
<td>28</td>
<td>4</td>
<td>29</td>
<td>29</td>
<td>New technologies that have worked significantly since ARE are electric vehicles (the draft mentions batteries) and autonomous driving. Sales are clearly demonstrated plug-in electric and hybrid dominate all other alternative power systems. Autonomous driving may complement that trend. Such vehicles might lead to a reduction in the size of the vehicle fleet although total vehicle km might rise as positioning to provide fast response times for rides. Operating costs will be very important given the large distance travelled annually by such vehicles, low operating costs favours electric vehicles. The increase in total fleet vehicle km will not matter if virtually all electricity is from non-emitting sources. [Elke Hau, Canada]</td>
<td>Taken into account in revised text.</td>
</tr>
<tr>
<td>11196</td>
<td>28</td>
<td>4</td>
<td>29</td>
<td>32</td>
<td>In the section on transport, the main focus is on electrification. Any reference to modal changes is extremely condensed and cycling is left unmentioned. [Michael Schaffer, Netherlands]</td>
<td>Accepted. Modal shifts covered in revised text.</td>
</tr>
</tbody>
</table>
The analysis is too short-term (see general comment above). Barrington-Leigh and Miller-Ball have argued that for long-term climate policy, the road networks laid down during initial construction of new residential developments are irremovable (for centuries). Therefore, drastic, urgent policy action may be needed in such areas where the pay-off is gradual, but the opportunity only exists in the short-term (during the current, first-phase of the one-time process of urbanization). Modal shift in the future may be highly constrained by whether the road networks are adaptable (high-connectivity), like a grid. Road networks are nearly impossible to change, so there is a high urgency to ensure new ones are laid down in a way which allows future demarketing, introduction of public transit, re-use shearing, introduction of mixed use, etc. etc. if these things are not necessarily intended. See Barrington-Leigh, C. P. and Adam Miller-Ball, “A Century of Sprawl in the United States,” Proceedings of the National Academy of Sciences, doi:10.1073/pnas.1004331113, 15 June 2015; and Barrington-Leigh, C. P. and Adam Miller-Ball, "More connected urban roads reduce US GHG Emissions," Environmental Research Letters, doi:10.1088/1748-9326/10/12/14 [Barrington-Leigh, Christopher. California]

This paragraph is about an example of how to use vehicle technology and urban development to reduce GHG emissions. It is accepted as written.

The feedback was that the paragraph is too general and does not follow a topic-wise mode paragraph. The paragraph is rewritten to be more specific and detailed. The paragraph is rewritten to be more specific and detailed. The paragraph is rewritten to be more specific and detailed.

Basing a paragraph on a single citation does not seem to build a strong text, instead I would suggest elaborating in a topic-wise mode paragraph by paragraph. [Roger Cremades, Germany]

Growth in Plug-in Electric Vehicles (PEVs), also more commonly referred to as PHEVs, sees literature, manufacturers websites, motoring press etc. Electric cars are not the only option and continuing to cause CO2 emissions when coal and oil are used for power generation. Windgas (methane) driven vehicles can be better examined. As well as indirect impacts of the EV trend. [Yana POPKOSTOVA, France]

The trade-offs have not been examined. The rapid growth of electricity vehicles creates a new mineral and raw resource usage mainly for the batteries and increased new dependencies, exploitation dynamics and at times higher GHG emissions at the extraction centers. Social justice issues need to be better examined. As well as indirect impacts of the EV trend. [Yana POPKOSTOVA, France]

TheEditors

The trade-offs have not been examined. The rapid growth of electricity vehicles creates a new mineral and raw resource usage mainly for the batteries and increased new dependencies, exploitation dynamics and at times higher GHG emissions at the extraction centers. Social justice issues need to be better examined. As well as indirect impacts of the EV trend. [Yana POPKOSTOVA, France]

The trade-offs have not been examined. The rapid growth of electricity vehicles creates a new mineral and raw resource usage mainly for the batteries and increased new dependencies, exploitation dynamics and at times higher GHG emissions at the extraction centers. Social justice issues need to be better examined. As well as indirect impacts of the EV trend. [Yana POPKOSTOVA, France]

Do Not Quote, Cite, or Distribute Page 74 of 159
Comment | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
7021 | 28 | 44 | 28 | 44 | Mitigation potential of EV's. This really dependent on how carbon-intensive is the electricity supply. | Accepted. Text has been substantially revised.
7194 | 28 | 44 | 28 | 44 | Mitigation potential of EV's. This really dependent on how carbon-intensive is the electricity supply. | Accepted. Citation included with note that efficiency usually more carbon efficient than oil and water to improve.
7075 | 28 | 44 | 28 | 44 | Mitigation potential of EV's. This really dependent on how carbon-intensive is the electricity supply. | Accepted. Text has been substantially revised.
1092 | 49 | 50 | 49 | 50 | What is meant with "geographies" in this context? | Noted.
14084 | 28 | 50 | 28 | 50 | What is meant with "geographies" in this context? | Accepted. This case study requires greater explanation in the context of Brazil's leading biofuel.
7133 | 28 | 52 | 28 | 52 | This is an assertion that appears anecdotal to the reader, since only one study from one city is mentioned, without describing the limitations of the study. | Accepted. Text has been revised.
561 | 28 | 53 | 28 | 53 | Schools may emerge as a viable mitigation option in some geographies... | Accepted. Text has been revised to reflect a broader span of literature.
23105 | 40 | 53 | 40 | 53 | I think that the sentence in line 48-52... | Taken into account. Text revised drawing on peer-reviewed literature.
7915 | 28 | 55 | 28 | 55 | Fuel cells, the source of the hydrogen (e.g. natural gas) is important when considering mitigation impact. | Taken into account. Text revised to include that point. Chapter does include a separate section (4.4.3) on behavioural aspects of change.
10933 | 28 | 54 | 28 | 54 | Fuel cells vehicles have a very low efficiency when considering the complete system (electricity mix-to-hydrogen-transported-distributed-to-electricity-to-wheels) besides of a very long hydrogen-station refueling time. | Taken into account. Text revised to include that point. Chapter does include a separate section (4.4.3) on behavioural aspects of change.
57 | 28 | 54 | 28 | 54 | Not sure what this paragraph is trying to say. | Accepted. Text revised so that Badwel quote is no longer used.
19321 | 29 | 55 | 29 | 55 | The argument that the hydrogen infrastructure is lacking appears to be too trivial. | Taken into account in revised text.
7199 | 20 | 2 | 20 | 2 | A recent scenario study by Giosandini et al. shows that solar, wind combined with hydrogen can provide power. | Accepted. A useful citation that has been incorporated in the revised text.
15416 | 23 | 4 | 23 | 4 | Another issue is the origin of the hydrogen used in the fuel cells. | Taken into account in revised text. Citations have not been used, as renewable hydrogen is dealt with elsewhere, but with the new focus on "urban" in this section the high-level points about urban design and feedbacks and storage has been included.
937 | 30 | 4 | 30 | 4 | I wonder if more information about how decarbonizing the transport sector requires the coordination of fueling stations and infrastructure for the new chosen fuel that are difficult to convert. | Taken into account in revised text.
9715 | 30 | 4 | 30 | 4 | No mention of carbon pricing as an important policy measure... | Taken into account in section 4.4.1.
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>9122</td>
<td>29</td>
<td>10</td>
<td>29</td>
<td>19</td>
</tr>
</tbody>
</table>
| Mitteil et al. (2017) show how much emissions from transport can be reduced by changing behavior and found that reduction potential can be increased by 45% by combining behavioral and technology related mitigation options like the mass-transit system speed improvement, transit oriented development, efficiency improvement, preference towards eco-friendly technologies and high vehicle occupancy. Taken into account in section on behaviour change and in this section. 

<p>| 9342       | 29        | 14        | 29      | 14      |
| The statement “Cars that have developed adaptation plans usually include attention to more resilient transport systems” may also be supported by the SECAP adaptation indicator on “Length of transport network (e.g. road) located in areas at risk (e.g. flood/drought/heat wave/ forest or land fire)” as noted in Comment 47 above. In this way, reference to SECAP guidelines may be included in addition to the existing reference to (UN-HABITAT, 2011). [Sir Klein, Turkey] Taken into account in revised text. |
| 955        | 29        | 17        | 29      | 29      |
| Found that this section on “peak car” has overlaid the empirical findings on this topic. This is especially the case, when a claim that “global data on these trends are now apparent” is based on a citation that is from a source that has not been peer reviewed. Recent studies have looked at the “peak car” issue and have found that changes in GDP and fuel prices are important in explaining why certain countries (such as the US, France, the UK, Australia and Germany) have had a temporary plateau in car travel. My concern is based on whether there is enough data and peer-reviewed publications that find that there has been a peak, rather than a plateau. The slow-down in the global economy is one of the issues here and finding that a peak has occurred is likely to only become a consensus with a long period of observation (possibly decades). While I would like the concept to be true (and do not own a car myself), I am drawn towards the research that finds that the slowdown in GDP and increases in fuel prices have created a plateau. Accepted and additional citations reviewed for inclusion in revised text but not included in substantially revised sections. The point about peak car is now contextualized with a counter point for developing countries. |
| 14141      | 29        | 18        | 29      | 18      |
| This is extremely light. There is an extensive analysis of the status of road freight transport and the opportunities available the ambition of the Paris Agreement (plus other goals aligned with the SDGs). See <a href="https://www.iea.org/publications/freepublications/publication/TheFutureofTrucksImplicationsforEnergyandtheEnvironment.pdf">https://www.iea.org/publications/freepublications/publication/TheFutureofTrucksImplicationsforEnergyandtheEnvironment.pdf</a>. [Pierpaolo Cazzola, France] Taken into account in revised text. |
| 14141      | 29        | 18        | 29      | 18      |
| An sentence defining peak car would be useful or a definition in box 4.10 and citing the box [Elvira Poloczanska, Germany] Accepted. Text revised to update AR5. |
| 18410      | 29        | 20        | 29      | 20      |
| “A peak car is now reaching the United States, as noted in a Rocky Mountain Institute 2017 study at <a href="https://rmi.org/insights/reports/peak-car-ownership-report/">https://rmi.org/insights/reports/peak-car-ownership-report/</a> [Jimmy Lovins, United States of America] Accepted. Text will be revised if literature subsequent to AR5 can be sourced. |
| 7076       | 19        | 19        | 29      | 29      |
| Peak car is now reaching the United States, as noted in a Rocky Mountain Institute 2017 study at <a href="https://rmi.org/insights/reports/peak-car-ownership-report/">https://rmi.org/insights/reports/peak-car-ownership-report/</a> [Jimmy Lovins, United States of America] Accepted. Text will be revised if literature subsequent to AR5 can be sourced. |
| 18841      | 29        | 20        | 29      | 20      |
| Given that the role of freight transport in GHG emissions is as important as of passenger transport, the discussion of freight transport is rather limited in this section and the reference to the literature is insufficient. [Jakob Wachsmuth, Germany] Accepted and additional citations reviewed for inclusion in revised text but not included in substantially revised sections. The point about peak car is now contextualized with a counter point for developing countries. |
| 1382       | 29        | 20        | 29      | 20      |
| The difference between “Geels and Schot (2010) explain the trend as a socio-technical innovation” and “Newman et al (2017) as a disruptive innovation” is not clear. [Pierpaolo Cazzola, France] Accepted and revised in new text to highlight the importance of innovation, not the difference between the two. The respective change do hold policy implications and are dealt with elsewhere. |
| 15411      | 29        | 21        | 29      | 21      |
| Newman et al. (2017) did not link to Menckley [Borja Mota, Japan] Accepted and additional citations reviewed for inclusion in revised text but not included in substantially revised sections. The point about peak car is now contextualized with a counter point for developing countries. |
| 11064      | 29        | 29        | 31      | 32      |
| Given that the role of freight transport in GHG emissions is as important as of passenger transport, the discussion of freight transport is rather limited in this section and the reference to the literature is insufficient. [Jakob Wachsmuth, Germany] Taken into account in revised text. |
| 17700      | 29        | 31        | 32      | 32      |
| This is extremely light. There is an extensive analysis of the status of road freight transport and the opportunities available the ambition of the Paris Agreement (plus other goals aligned with the SDGs). See <a href="https://www.iea.org/publications/freepublications/publication/TheFutureofTrucksImplicationsforEnergyandtheEnvironment.pdf">https://www.iea.org/publications/freepublications/publication/TheFutureofTrucksImplicationsforEnergyandtheEnvironment.pdf</a>. [Paarps Cataz, Italy] Accepted. Text revised. |
| 7530       | 29        | 31        | 32      | 32      |
| Please consider referring to the mitigation options for aviation and freight described in 4.3.2.4 - International transport options [Byrdy Christophersen, Norway] Accepted. Text revised to update AR5. |
| 20105      | 29        | 31        | 32      | 32      |
| As regards global levels of freight and air travel, the IPCC should not only consider decarbonisation, which is problematic if done via biofuels as pointed out in the comment above, but also explore literature on possibilities of reducing absolute numbers, drawing on literature on restructuring international trade and commerce relations. [Jill Fufu, Germany] Taken into account in section on behaviour change and in this section. |
| 19412      | 29        | 31        | 32      | 32      |
| What percentage of emissions are associated with the air transport sector, and what does that mean for the continuing trend of decarbonising - is there any historical data available from the ICAO? [Sumetee Pahwa, India] Accepted. Text revised to place greater emphasis on transport systems. |
| 758        | 29        | 31        | 32      | 32      |
| Why is hydrogen not mentioned here as a decarbonisation fuel? A Google Scholar search on “hydrogen + aviation” indicates that it has been in the literature since at least 1988 [Shihae Kim, United Kingdom (of Great Britain and Northern Ireland)] Accepted. Text revised to place greater emphasis on transport systems. |
| 7823       | 29        | 31        | 32      | 32      |
| My forthcoming comments on section 4.3.4 show that there are two main gaps in this section: (1) the lack of consideration of existing relevant research and technologies, and (2) the need for a more comprehensive treatment of the issue of decarbonising freight transport. [Sumetee Pahwa, India] Accepted. Text revised to place greater emphasis on transport systems. |</p>
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>957</td>
<td>29</td>
<td>31</td>
<td>29</td>
<td>32</td>
<td>There is a limited discussion of future trends in freight. A recent special issue has focused on long-term transport scenarios that include freight transport. The analysis of new and emerging transport modes, such as offshore freight vessels, is underdeveloped.</td>
<td>Accepted. Text revised to update AR5.</td>
</tr>
<tr>
<td>7677</td>
<td>31</td>
<td>31</td>
<td>29</td>
<td>32</td>
<td>My foregoing comments on section 4.3.4 above have underestimated the importance of freight transport in achieving climate change targets.</td>
<td>Accepted. Text revised to place greater emphasis on transport systems.</td>
</tr>
<tr>
<td>14087</td>
<td>32</td>
<td>32</td>
<td>29</td>
<td>32</td>
<td>In section 4.3.4.4 the statement regarding the potential of alternative fuels for air travel is rather pessimistic, but it is not addressed here. The message should be coherent across this chapter.</td>
<td>Accepted. Text will be revised if literature subsequent to AR5 can be sourced.</td>
</tr>
<tr>
<td>7198</td>
<td>32</td>
<td>32</td>
<td>29</td>
<td>32</td>
<td>A recent study by Verhoef et al. (2017) on the potential of additive manufacturing on the transport sector shows that, in the aerospace sector, energy savings of 5-25% can be made, depending on global co-operation and penetration of the technology, with the largest effect in the use phase because of weight reduction, thus suggesting energy policy makers to also focus on these and other disruptive technologies, as they may be very influential on CO2 emissions.</td>
<td>Noted. This section now focuses on urban infrastructure and not manufacturing.</td>
</tr>
<tr>
<td>1071</td>
<td>33</td>
<td>33</td>
<td>29</td>
<td>32</td>
<td>Add “A short distance air travel can be replaced by high speed train networks.” [Peter Van Velthoven, Netherlands] Accepted.</td>
<td></td>
</tr>
<tr>
<td>6199</td>
<td>35</td>
<td>35</td>
<td>29</td>
<td>42</td>
<td>I believe that this chapter should be expanded. [Marco Mazzotti, Switzerland] Accept.</td>
<td></td>
</tr>
<tr>
<td>6305</td>
<td>35</td>
<td>35</td>
<td>29</td>
<td>52</td>
<td>There is a particularly short section in this part of the report which is widely regarded as a particularly fuzzy question for decarbonisation - control and steel in particular, both of which entail direct CO2 emissions as well as the energy-related emissions. Warrants a fuller discussion.</td>
<td>Accept. See response to comment #3075.</td>
</tr>
<tr>
<td>3075</td>
<td>35</td>
<td>35</td>
<td>29</td>
<td>53</td>
<td>Industry section 4.3.3.3 is weak considering the scale of associated emissions, especially compared to the following much longer and fuller sections on CCUS, BECCS and DACS. I would state this explicitly. [Christopher Batelle, Canada]</td>
<td>Accept. A separate section (4.3.5) was created to review “industrial system transitions”.</td>
</tr>
<tr>
<td>4894</td>
<td>35</td>
<td>35</td>
<td>29</td>
<td>53</td>
<td>The industrial transition should be covered in more detail and with more perspectives. As examples, internet of things, industry 4.0, are currently not even mentioned. [Sigrid Kusch, Germany]</td>
<td>Accept. A separate section (4.3.5) was created to review “industrial system transitions”.</td>
</tr>
<tr>
<td>19322</td>
<td>35</td>
<td>35</td>
<td>29</td>
<td>53</td>
<td>I believe that this chapter should be expanded. [Marco Mazzotti, Switzerland]</td>
<td>Accept. See response to comment #3075.</td>
</tr>
<tr>
<td>3618</td>
<td>35</td>
<td>35</td>
<td>30</td>
<td>1</td>
<td>Only 2 paragraphs on the changes required in industrial sector? Given the relative share of GHG contributions from industry this is a major gap.</td>
<td>Accepted. A separate section (4.3.5) was created to review “industrial system transitions”.</td>
</tr>
<tr>
<td>4893</td>
<td>35</td>
<td>35</td>
<td>29</td>
<td>53</td>
<td>The topic of circular economy, including recycling, should be covered in more detail. Circular economy and more widespread implementation of renewable energy and green technologies are key to decarbonising the industrial sector. As examples, rare Earth Elements, and more generally Critical Raw Materials, are fundamental materials for many green technologies, including wind power plants, batteries for electric vehicles, and many more technologies. Their availability is a bottleneck to more widespread adoption of green technologies, and recycling is clearly required if the scenarios for technology changes are to be considered feasible. [Sigrid Kusch, Germany]</td>
<td>Accepted. A separate section (4.3.5) was created to review “industrial system transitions”.</td>
</tr>
<tr>
<td>7924</td>
<td>35</td>
<td>35</td>
<td>29</td>
<td>42</td>
<td>The discussion of decarbonising energy-intensive industry leaves out the three most important technologies that should come first: advanced energy efficiency, alternative processes (e.g. for cement-making—most of the huge energy reductions are available from process alternatives now entering the market), and material efficiency (as those that let New York’s World Trade Center save two-thirds of its cement through better design using higher-quality materials). SRI (2017) found major benefits on efficiency for such methods that:</td>
<td>Accepted. Revised text in new section contains greater emphasis on energy efficiency.</td>
</tr>
</tbody>
</table>

**References:**

The text references a variety of sources, including academic articles and reports, to support the arguments made. For example:

- IEA (2010), Worrell et al. (2003).
- Lovins, Amory (1991) through Lovins (2005, 2007, 2010) and Lovins & RMI (2011) to Lovins (2017) shows that standard assessments, immediate. Lovins (2017, 2018) show its importance, profitability, and expanding returns. I have led the design of such improvements in more than $40 billion worth of diverse industrial facilities, oil and gas, around the world, and have yet to find a place where they are not broadly applicable. Indeed, a line of work from Lovins & Lovins (1991) through Lovins (2005, 2007, 2010) and Lovins & RMI (2011) to Lovins (2017) shows that standard assessments, including prior ones by IPCC, completely omit the fluid-handling opportunity—compared to current operating patterns. If instead it is meant to refer to growth of service demand, that should be clarified, but then the second half of the sentence doesn’t fit the first half. My comments above about the seaward gap underway and available in heavy-road efficiency, and even more in additive efficiency, still don’t even count freight logistics. A 2016 Shenzhen shock audit found that the amount of Chinese truck-km run-empty is about twice the OECD norm (http://www.mm-china.com/assets/pdf/new/ft/ft_Freight_Cleaner_Report_English.pdf), and the Chinese authorities are moving aggressively to close or reverse that gap through a software platform akin to “Uber for freight.” [Amory Lovins, United States of America]

**Note:**

- The text includes a variety of references to support the arguments made, including academic articles and reports.
- The text discusses the importance of advanced energy efficiency, alternative processes, and material efficiency in decarbonising the industrial sector.
- The text highlights the potential benefits of such improvements, which have been shown to be broadly applicable globally.
- The text notes that there is a limited discussion of future trends in freight transport and that a recent special issue has focused on long-term transport scenarios that include freight transport.
- The text suggests that more detailed coverage is needed of the industrial transition, including discussions of circular economy, recycling, and the potential benefits of rare earth elements and other critical raw materials.
- The text acknowledges that there is a major gap in the discussion of the changes required in the industrial sector, given the relative share of GHG contributions from industry.
- The text notes that the discussion of decarbonising energy-intensive industry leaves out the three most important technologies that should come first: advanced energy efficiency, alternative processes, and material efficiency.

**Conclusion:**

The text effectively presents a detailed discussion of the changes required in the industrial sector, highlighting the importance of advanced energy efficiency, alternative processes, and material efficiency. It acknowledges gaps in the discussion, particularly in terms of future trends in freight transport and the industrial transition, and suggests that more detailed coverage is needed to address these gaps. The text also highlights the potential benefits of rare earth elements and other critical raw materials in the decarbonisation of the industrial sector.
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>7078</td>
<td>29</td>
<td>36</td>
<td>29</td>
<td>42</td>
</tr>
<tr>
<td>Comment</td>
<td>The discussion of decarbonising energy-intensive industry leaves out the three most important items that should come first: advanced energy efficiency, alternative processes (e.g., for cement-making—order-of-magnitude energy reductions), and materials efficiency (as those that let New York’s World Trade Center save two-thirds of its current through better design using higher-quality materials). ERI (2017) found major knock-on benefits from such methods in China. But the best low-carbon advanced efficiency is, more obvious in the immediate, Lovins (2017, 2018) shows its importance, profitability, and expanding returns. I have left the design of such improvements in more than $40 billion worth of diverse industrial facilities, old and new, come to the fore. And then, indeed, a line of work from Lovins &amp; Lovins (1991) through Lovins (2003, 2007, 2010) and Lovins &amp; RMI (2011) to Lovins (2017) shows that standard assessments, including prior ones to IPCC, completely omit the fluid-handling opportunity (from making pipes and ducts fat, short and straight rather than thin, long, and crooked) that could save about 1.5 of the world’s electricity with extremely short paybacks. Even the most efficient-official industry forecast, or engineering textbook—cannot explain because it’s not a technology but a design method (and that lost a Victorian one on that). It would be a great lost opportunity if this study, tackling the most urgent questions of climate protection, continued to look modern efficiency as technology and fail to see that past analysts have wrestled with modest potential and rising cost—neither of which is empirically demonstrable (Lovins 2017). It is also important to note that as in buildings (Bendewald et al. 2014, 2015, Muldavin 2010), industrial efficiency virtually always has important positive externalities to the owner/operator (EIA 2010; Worrell et al. 2003) [Amon Lovins, United States of America].</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7129</td>
<td>29</td>
<td>41</td>
<td>29</td>
<td>41</td>
</tr>
<tr>
<td>Comment</td>
<td>Delete the text “and the development of a circular economy industry” [Eleni Kaditi, Austria].</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10504</td>
<td>29</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comment</td>
<td>In developed countries, industry often accounts for a third of energy use and as much CO2 emissions. So, additionally, energy-intensive industrial processes can usually be massively improved. Such improvements include: 1. Better energy efficiency by better thermal insulations of buildings and machinery 2. Reuse of waste heat with high-temperature thermal pumps (today high-temperature thermal pumps can exceed 100°C with sometimes COP of up to 5) 3. Improved processes using less energy (e.g. using very high pressure instead of high temperatures for baking concrete) 4. Use of concentrated thermal solar power for high-temperature generation. Governments can help industries achieve energy efficiency programs sponsoring energy studies (e.g. Canton de Vaud in Switzerland sponsors up to 10,000 SFr in start-ups, and in that part of the efficiency improvement costs). Often 50 to 80% energy use decrease result from this program, which then also helps increasing competitiveness in addition to decarbonization. [Beat Brunner, Switzerland]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7889</td>
<td>29</td>
<td>42</td>
<td>29</td>
<td>43</td>
</tr>
<tr>
<td>Comment</td>
<td>Include reference / mention of the developments of a global Circular Economy and transition from a Linear to a Circular system e.g: source adapted from: <a href="http://www.eeas.europa.eu/delegation/brussels/eeas_15_CE_web_connected.pdf">http://www.eeas.europa.eu/delegation/brussels/eeas_15_CE_web_connected.pdf</a>) The case for a circular economy on Europe has been led by several recent studies which identify the following benefits, which could derive from a circular economy: contributing to EU climate change policy by reducing greenhouse gas emissions; improved competitiveness by creating savings and reducing raw materials and energy dependency; improved security of supply and control of rising costs; employment opportunities; reducing environmental impact of waste extraction and waste disposal; opportunities for new business creation from earning revenue by selling goods to offering services. Underlying the barriers to shifting from a linear to a circular economy is the failure of current pricing systems to fully integrate all costs (including social and environmental costs), which means that pricing systems are failing to transmit the necessary information to inform individual decisions as related to climate change. A research priority is thus to increase the pace at which these external costs can be introduced. Until this failure remedied, rules and regulatory instruments may be undesirable, but need to be carefully designed, taking into account financials of behavioural economics, and providing sufficient flexibility to allow companies to respond in the most efficient ways and to respond to rapid changes in technology and associated effects on product life cycles. The potential impact of a circular economy on international competitiveness is also considered. There is potential for improved competitiveness and new markets, but there are also potential disadvantages from an economic theory perspective where policies for a circular economy are applied only within the European Union. It is thus important to ensure that these policies are also fully embraced in international trade negotiations, and the United Nations policy process involving Sustainable Development Goals. [Geralda Ann Cusack, Ireland]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>759</td>
<td>29</td>
<td>44</td>
<td>29</td>
<td>53</td>
</tr>
<tr>
<td>Comment</td>
<td>I would like to see a paragraph about how “Electrification of manufacturing processes and material substitution” could be implemented as part of the industrialisation of the developing world. There are a lot of issues, and the new technology could be the catalyst for change in the industrialised nations when it comes time to replace technology. [Kosuke Kim, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15002</td>
<td>29</td>
<td>45</td>
<td>29</td>
<td>45</td>
</tr>
<tr>
<td>Comment</td>
<td>Technology transfer should be expanded here to include “technology development, deployment, diffusion and transfer” [Parth Athar, United States of America].</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4875</td>
<td>29</td>
<td>47</td>
<td>29</td>
<td>47</td>
</tr>
<tr>
<td>1728</td>
<td>29</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comment</td>
<td>Taking into account relevant text has been removed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>562</td>
<td>29</td>
<td>48</td>
<td>29</td>
<td>48</td>
</tr>
<tr>
<td>Comment</td>
<td>Electrification of manufacturing would constitute a greater technological challenge. It is unclear why there is any technological challenge at all. There are already electric arc furnaces, direct reduction and electric reduction furnaces available. Please see Jacobson et al. (Joule, 1, doi:10.1016/j.joule.2017.07.008, 2017, referenced above). [Mark Jacobson, United States of America]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2373</td>
<td>29</td>
<td>48</td>
<td>29</td>
<td>53</td>
</tr>
<tr>
<td>Comment</td>
<td>This paragraph refers to stranded assets (SAs): SAs should not be permitted as a barrier to action, instead SAs are the beneficial consequence of the transition to a 1.5 world. [David Viner, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The literature is clearer on the need for clean electricity for industrialisation in developing countries. There are very few peer-reviewed studies making this point.
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
1 | 29 | 46 | 29 | 51 | All at the end of the sentence about electrification of industry, a reference to energy savings by the use of appropriate electronic control techniques, motor control [Bmil K. Bouse, Power Electronics and Motor Drive Research Progress and Perspective; IEEE Transactions On Industrial Electronics, India Science Center, Piscataway, NJ, USA, Vol. 58, No. 2 - 2009-02-01. Pág.: 581 - 588; ISBN 07803-0946-4] and effective electric heating (induction heating, industrial use of microwave heating) should be made. Perhaps this could be done in the frame of a more global reference to smart factories and Industry 4.0, and stress the importance of ICT in an energy efficient industry [F. Shrouf; J. Ordieres; G. Miragliotta “Smart factories in Industry 4.0. A review of the current end of energy management approaches in production based on the Internet of Things paradigm”. IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), 2014 - 9-12 Dec. 2014]. Electrification should be accompanied of the pertinent control or regulation technologies that will optimize the energy management of the concerned industrial process. [Fancesco Javier Hulten Abd, Germany]| Taken into account/Revised. No peer reviewed literature suggested. However, more emphasis on energy efficiency in motors is included in the section on industry, and the ICT advances are discussed in section 4.4.4.
2 | 29 | 51 | 29 | 51 | Delete the text “and developing a circular economy”, [Eleni Kaditi, Austria]| Rejected: The text is based on literature references to a circular economy, which is an important concept in 1.3C-compatible industry.
3 | 29 | 52 | 29 | 52 | Be more specific what the advanced capabilities imply for institutions. [Elvira Poloczanska, Germany]| Taken into account in section 4.4.4.
4 | 29 | 53 | 29 | 55 | To reduce the challenge and uncertainty, an acceleration of information dissemination and/or public campaigns on the scope-opensesimmetry is necessary so that the public understands the huge savings the circular economy investment could bring in the medium to long term. [Yana POPKOSTOVA, France]| Taken into account in Section 4.4.1 but literature suggests that uncertainty will remain a feature (see Darren and Salterbook).| 5 | 3 | 0 | 2 | Add information from Graheas et al., 2018 (In Press) [Cynthia Rosenzweig, United States of America] | Noted: Waiting appearance of paper.
6 | 30 | 2 | 30 | 2 | Climate services are typically useful in cities for example in Cape town, water infrastructure design now takes CC into account [Singh et al., 2017. The utility of weather and climate information for adaptation decision-making: current uses and future prospects in Africa and India[Philippe Roulier, France]]| Accepted - text revised to include reference to urban climate services.
8 | 30 | 4 | 30 | 37 | This section 4.4.4.1 may be too general to be of any use? Could there be a table or any further categorization of resilience building actions for different roles (as well as regions and sectors ideally)? [Elvira Mela, Sweden]| Accepted. Text has been substantially reviewed.
9 | 30 | 4 | 30 | 37 | The section is difficult to follow and does not accurately reflect the current state of discourse within urban adaptation planning as 1 relates to the conflicts and synergies between adaptation, resilience and disaster risk reduction. This section is missing key citations. I’d be happy to speak with the team to discuss. [Jean Kearan, United States of America]| Accepted. Text has been substantially reviewed.
10 | 30 | 4 | 30 | 37 | How does climate resilience relate to disruptive technologies? The juxtaposition between the two reflects the tensions in the discourses which differ on where societal efforts must be placed - behind enablers such as community engagement and public monitoring of environmental performance or innovators which subvert mainstream practices. [Sunmata Paheka Gajjar, India]| Accepted. Text has been substantially reviewed.
11 | 30 | 4 | 30 | 40 | not consistent for title of 4.3.4.4.2 with title of 4.3.4.4, because 4.3.4.4 for adaptation, but 4.3.4.4.2 is only mitigation [Jianguo Wu, China]| Accepted. Text has been revised.
12 | 30 | 6 | 30 | 8 | I have no excuse to Saterthwaite and Bartlett (2016), but it seems more plausible that mitigation can influence the adaptation “needs”, rather than the “capacity” of communities. [Michel Schiewer, Netherlands]| Accepted. This section has been rewritten. The sentence is no longer on place and the citation is no longer in use.
13 | 30 | 10 | 30 | 26 | have not had a look at the book by Saterthwaite and Bartlett, but I will wonder if examples from other regions or types of economies are also included? [Elvira Mela, Sweden]| Accepted. This section has been rewritten. The sentence is no longer on place and the citation is no longer in use.
14 | 30 | 10 | 30 | 31 | 4.3.4.4.1 Disaster risk reduction and resilience building 

Area population is equivalent to about 60% of the total world population. Therefore, some megacities in Asia should also be introduced, e.g.: The risk of higher storm surge, coupled with different sea-level-rise scenarios, highlights how the dykes around Tokyo could fail unless adaptation measures against climate change are attempted (Hoshino et al., 2015). Likewise, present coastal dykes in Jakarta will help to prevent flooding for a while, though their effectiveness will eventually disappear as land subsidence and sea-level-rise continues (Tagaki et al., 2011). | Rejected. DRR will be discussed in SGD

References


15 | 30 | 15 | 30 | 15 | Mechanical response not linked to Mandible [Whalen Micromaus Oda, France]| Editorial

16 | 30 | 23 | 30 | 23 | Add information about role of short term pollutants in urban areas. Cle: Becker et al., 2018 (In Press) [Cynthia Rosenzweig, United States of America] included | Rejected: Unable to cite the paper as not in public circulation. Reference to air pollution has been included.

17 | 30 | 24 | 30 | 25 | Delete the text “to the rise of a lower carbon future”, [Ellen Kaditi, Austria]| Accepted. Text revised.

18 | 30 | 28 | 30 | 33 | In relation to urban adaptation and resilience, this paragraph would benefit from a clear and sharp description of the mentioned “institutional structures”, practices that “emphasized knowledge, networks, information, and greater engagement of citizens with the state” is in my humble opinion insufficient and too general, in this respect. (Rogier Cremades, Germany)| Accepted. Text revised.
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>18032</td>
<td>30</td>
<td>28</td>
<td>30</td>
<td>33</td>
</tr>
<tr>
<td>Comment</td>
<td>Please, consider adding to the paragraph: Participatory action-research — through iterative cycles between research and practice — may promote incremental and transformative changes in the context of urban climate change adaptation (Campos et al., 2016). To enhance risk assessment and climate adaptation processes, and to support the capacity of communities to prepare for change integrating scientific and local knowledge is essential (Mosier and Dilling, 2007; Kettle et al., 2014). Local knowledge on the complex details of community characteristics, such as infrastructure design, governance structure, and vulnerable populations need to be incorporated in the assessments of local risks, and at the same time, local managers need to be equipped with information on climate change impacts and projections for their regions (Amsden et al., 2010; Pielke et al., 2012; Kettle et al., 2014).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. The point about community participation in urban planning has been reallined and relevant urban citases since AR5 have been included. Campos, citation added, (as well as processes (Archer et al. 2014; Kettle et al. 2014; Sutera 2017). The point about MLG is reflected under “enabling environment”. The citations are not, however, expliely about “urban” which is the focus of this section.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30261</td>
<td>30</td>
<td>29</td>
<td>30</td>
<td>33</td>
</tr>
<tr>
<td>Comment</td>
<td>Facilitating these meaningful outcomes requires safe arenas where citizens can grapple with the daily experiences of local climate challenges. (Morien)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. Text revised. But this point about trust and social learning is mostly dealt with under “Enabling Environment”.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1304</td>
<td>30</td>
<td>30</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Comment</td>
<td>The words “there are” seem to be missing from this sentence. (Colin Raymond, United States of America)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. Text revised.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1465</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Comment</td>
<td>Talking about migration? (Philippe Roouffe, France)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. Migration is now addressed in a separate section to do it justice.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14252</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Comment</td>
<td>Migration section will be put in? Is this human migration? That’s needed in this context! (Jason Diner, Canada)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. Migration is now addressed in a separate section to do it justice.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7106</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Comment</td>
<td>This section 4.3.4.2 still to be developed - it’s key from my perspective. E.g. in Sweden, the combination of current long-distance/international migration waves (2015-year expected) and short-distance rural-to-urban migration is challenging national strategies for prioritization and building capacity, and in conflict with migration strategies. Actors at all levels have to choose - due to capacity and time constraints - between quickly providing new dwellings for over half a million migrants expected to move to the biggest Swedish cities currently or investing a lot of time and resources into providing short-term housing. This is the case in other cities everywhere on the other side, the 1.5°C may imply less migration than the 2°C, something possible to stress and quantify? (Erika Mario, Sweden)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. Migration is now addressed in a separate section to do it justice.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1474</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Comment</td>
<td>The ‘migration’ section appears to be missing - this is a crucial element of adaptation and needs significant coverage. For a 1.5°C C conomy many countries (e.g. SEAs) will still see enforced migration as a result of climate change impacts (e.g. sea-level rise). It would be useful to provide an overview of measures for migration, as an adaptation strategy, existing plans (e.g. Trump’s ‘anti-immigration’) and the socioeconomic impacts of such planned migration. (David Reay, United Kingdom (of Great Britain and Northern Ireland))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. Migration is now addressed in a separate section to do it justice.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19414</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Comment</td>
<td>Section 4.3.4.2 Migration as an adaptation strategy is highly contested. Especially, with regards to urban migration and relocation, vulnerability has been found to be entrenched (Gajjar et al., 2018); and in situations where those who migrate do not necessarily possess the agency to improve their lot in their destinations. (Sumette Pahwa Gajjar, India)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. Migration is now addressed in a separate section to do it justice.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15040</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Comment</td>
<td>The SLCF section is good. It should acknowledge the Kigali agreement on HFCs to bring them into the Montreal protocol and discuss the effects of this. (British Columbia, Canada)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. The point about community participation in urban planning has been reallined and relevant urban citases since AR5 have been included. Campos, citation added, (as well as processes (Archer et al. 2014; Kettle et al. 2014; Sutera 2017). The point about MLG is reflected under “enabling environment”. The citations are not, however, expliely about “urban” which is the focus of this section.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10218</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Comment</td>
<td>The SLCF section is good. It should acknowledge the Kigali agreement on HFCs to bring them into the Montreal protocol and discuss the effects of this. It should state that many of these species are co-emitted with CO2, so they are not necessarily additional mitigation options (Pires Forster, United Kingdom (of Great Britain and Northern Ireland))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. The point about community participation in urban planning has been reallined and relevant urban citases since AR5 have been included. Campos, citation added, (as well as processes (Archer et al. 2014; Kettle et al. 2014; Sutera 2017). The point about MLG is reflected under “enabling environment”. The citations are not, however, expliely about “urban” which is the focus of this section.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Comment</td>
<td>The chapter on “short-lived climate pollutants” would benefit from including a discussion of the economic and political benefits of mitigation. Suggested text and references: Global assessments have indicated a potential large net economic benefit from mitigating SLCPs when climate, health and crop benefits are accounted for (Shindell et al 2012; UNEP/WMO 2012; Victor et al 2012); Recent research confirms that benefits outweigh cost for a majority of mitigation options also from a national perspective, but that international cooperation may be vital in realizing these potential benefits (Assar et al)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. The point about community participation in urban planning has been reallined and relevant urban citases since AR5 have been included. Campos, citation added, (as well as processes (Archer et al. 2014; Kettle et al. 2014; Sutera 2017). The point about MLG is reflected under “enabling environment”. The citations are not, however, expliely about “urban” which is the focus of this section.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Comment</td>
<td>The chapter on “short-lived climate pollutants” would benefit from including a discussion of the economic and political benefits of mitigation. Suggested text and references: Global assessments have indicated a potential large net economic benefit from mitigating SLCPs when climate, health and crop benefits are accounted for (Shindell et al 2012; UNEP/WMO 2012; Victor et al 2012); Recent research confirms that benefits outweigh cost for a majority of mitigation options also from a national perspective, but that international cooperation may be vital in realizing these potential benefits (Assar et al)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td>Accepted. The point about community participation in urban planning has been reallined and relevant urban citases since AR5 have been included. Campos, citation added, (as well as processes (Archer et al. 2014; Kettle et al. 2014; Sutera 2017). The point about MLG is reflected under “enabling environment”. The citations are not, however, expliely about “urban” which is the focus of this section.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do Not Quote, Cite, or Distribute Page 80 of 159
The topic of SLCPs needs and deserves more than 2 pages in this long report! Since length allocations are often made top-down, I know this may not be the fault of the authors that will write these comments, so hopefully this can be passed up “higher”. Numerous publications - including papers in Science, Nature and PNAS and prominent reports from UNEP and a recent one from an expert committee (http://www.grida.no/pdfs/CommentResponse20171019VoU2-2DegreesCelsiusReport2017.pdf): I have shown that it is not feasible to stay well below 2°C, let alone remain under 1.5°C, without concerted efforts to reduce emissions of SLCPs and their precursors. This is hardly acknowledged here or elsewhere in the FOD report. Why? While it is clear that it is important to be careful that SLCPs do not divert efforts to reduce CO2 (a point that was made clearly by Schmale et al., 2014, which is cited in this section), the same holds for CDR and SRM, and they get 1½ as much space as the SLCPs — in fact, the highlighted comments in Chapter 3 on CH4 removal get nearly as much space (section 3.4.4.4) as the part of the SLCP’s discussion focused on CH4 mitigation. There are several improvements that could be made in the section, and I provide a few example comments here, but in the end it would be difficult for any authors to provide an adequate overview of the topic in this limited space. This provides the terrible misimpression that SLCPs are some sidetrack topic in the efforts to stay under 1.5°C, which is not at all the case. While they would become considerably less important as we approach 3°C, their mitigation is absolutely essential to achieve 1.5°C. I hope those in charge of page allocations will understand this and give the authors the space that they need to deal with this topic adequately. (Mark Lawrence, Germany)

Both terms SLCPs and SCFCs are used intermingled here. Please stick with SCFCs, which is the proper terminology in the context of this report, and just mention once that SLCPs is used in some other contexts, particularly by the CCAC. This also goes for other chapters where SCFPs and SCFCs are both used (e.g., Chapter 2). (Mark Lawrence, Germany)

The section doesn’t make clear why SLCPs are relevant for 1.5°C. Their effects on warming in near 1.5°C pathways must be downplayed. It must be explained that much of methane is reduced alongside CO2 measures without which 1.5°C would be impossible. That potential growth in HFCs must be reduced without which 1.5°C would be impossible, and that - despite all the co-benefits explained at length here - BC is irrelevant - is a key lesson from peak warming in near 2°C pathways (Rogelj et al. 2014; Rogelj et al. 2015). BC reductions are only relevant in baseline CO2 scenarios and in those cases 1.5°C is a reasonable aim (Michał Schaeffer, Netherlands)

The UNEP/WMO assessment on Black Carbon and Tropospheric Ozone 2011 as well as Shindell et al at 2012 are important references to introduce at the beginning of this section as these led directly to the formation of the CCAC and activities to address SLCPs. (Jan Fuglestvedt, Norway)

Having worked with the MAGICC code some years ago exploring the relative effects of various types of pollutants, the results indicated that positive forcing during the 21st century from 21st century emissions are about equal for methane and for tropospheric ozone. Thus, I am wondering why tropospheric ozone is not also listed here. That it is created mostly by co-pollutants from other use of fossil fuels for transportation, etc., it may be that its warming in real CO2 pathways (Rogelj et al 2014; Rogelj et al 2015). BC reductions are only relevant in baseline CO2 scenarios and in those cases 1.5°C is a reasonable aim (Michał Schaeffer, Netherlands)

The topic of SLCPs needs and deserves more than 2 pages in this long report! Since length allocations are often made top-down, I know this may not be the fault of the authors that will write these comments, so hopefully this can be passed up “higher”. Numerous publications - including papers in Science, Nature and PNAS and prominent reports from UNEP and a recent one from an expert committee (http://www.grida.no/pdfs/CommentResponse20171019VoU2-2DegreesCelsiusReport2017.pdf): I have shown that it is not feasible to stay well below 2°C, let alone remain under 1.5°C, without concerted efforts to reduce emissions of SLCPs and their precursors. This is hardly acknowledged here or elsewhere in the FOD report. Why? While it is clear that it is important to be careful that SLCPs do not divert efforts to reduce CO2 (a point that was made clearly by Schmale et al., 2014, which is cited in this section), the same holds for CDR and SRM, and they get 1½ as much space as the SLCPs — in fact, the highlighted comments in Chapter 3 on CH4 removal get nearly as much space (section 3.4.4.4) as the part of the SLCP’s discussion focused on CH4 mitigation. There are several improvements that could be made in the section, and I provide a few example comments here, but in the end it would be difficult for any authors to provide an adequate overview of the topic in this limited space. This provides the terrible misimpression that SLCPs are some sidetrack topic in the efforts to stay under 1.5°C, which is not at all the case. While they would become considerably less important as we approach 3°C, their mitigation is absolutely essential to achieve 1.5°C. I hope those in charge of page allocations will understand this and give the authors the space that they need to deal with this topic adequately. (Mark Lawrence, Germany)

The topic of SLCPs needs and deserves more than 2 pages in this long report! Since length allocations are often made top-down, I know this may not be the fault of the authors that will write these comments, so hopefully this can be passed up “higher”. Numerous publications - including papers in Science, Nature and PNAS and prominent reports from UNEP and a recent one from an expert committee (http://www.grida.no/pdfs/CommentResponse20171019VoU2-2DegreesCelsiusReport2017.pdf): I have shown that it is not feasible to stay well below 2°C, let alone remain under 1.5°C, without concerted efforts to reduce emissions of SLCPs and their precursors. This is hardly acknowledged here or elsewhere in the FOD report. Why? While it is clear that it is important to be careful that SLCPs do not divert efforts to reduce CO2 (a point that was made clearly by Schmale et al., 2014, which is cited in this section), the same holds for CDR and SRM, and they get 1½ as much space as the SLCPs — in fact, the highlighted comments in Chapter 3 on CH4 removal get nearly as much space (section 3.4.4.4) as the part of the SLCP’s discussion focused on CH4 mitigation. There are several improvements that could be made in the section, and I provide a few example comments here, but in the end it would be difficult for any authors to provide an adequate overview of the topic in this limited space. This provides the terrible misimpression that SLCPs are some sidetrack topic in the efforts to stay under 1.5°C, which is not at all the case. While they would become considerably less important as we approach 3°C, their mitigation is absolutely essential to achieve 1.5°C. I hope those in charge of page allocations will understand this and give the authors the space that they need to deal with this topic adequately. (Mark Lawrence, Germany)
10638 31 2 31 4
We note that BC is rarely emitted alone... this is correct, but then the section fails to mention the much more important connection CO2 is rarely emitted alone, and the main co-emitter of particulates. Thus when CO2 is targeted - as it should be - CO2 and other emissions will be decreased. This can even lead to a near-term warming (as shown in the UNEP reports and accompanying Shindell (highlight) paper) making the benefit of overriding 1.5C even greater, unless BC and CH4 are not explicitly targeted with separate measures. This is really the appropriate framing for the SLCF's discussion. Note that this framing is already made clear in Chapter 2, p. 14, 24-31. SLCFs are often co-emitted with CO2 so in mitigation scenarios many CO2-targeted mitigation measures also reduce SLCF forcing magnitude (Rogelj et al. 2014; Shindell et al. 2012). Reduction in S2O2 emissions largely associated with fossil fuel burning are expected to reduce the cooling effects of both aerosol radiative interactions and aerosol/cloud interactions, leading to warming.  "Mark Lawrence, Germany"

Accept. We are not making this point here but in chapter 2, as stated in the comment. Will refer to chapter 2 in the text.

12294 31 5 31 5
I think "front-loaded warming" is not clear to all readers.  "Jan Fuglestvedt, Norway"

Accept. Wording will be clarified.

18416 31 6 31 9
This is a very important statement. Although covered starting on line 26, I would urge mentioning in this paragraph that there are important co-benefits from cutting emissions of most SLCPs. Indeed, I think it would be helpful to add a column regarding these co-benefits to Table 4.2. "Michael MacCracken, United States of America"

Accept. Is added to the table with reference to Shindell et al (Submitted).

20798 31 11
I think it would be fair to include Shindell et al 2012 here as this sets the ball rolling on SLCFs. "Johan Carl Ivar Kuylenstierna, United Kingdom (of Great Britain and Northern Ireland)"

Accept. Shindell is cited all over the section already.

20851 31 11
I think it would be fair to include Shindell et al 2012 here as the set the ball rolling on SLCFs. " Johan Carl Ivar Kuylenstierna, United Kingdom (of Great Britain and Northern Ireland)"

Reject. Shindell is cited all over the section already.

6375 31 11
Table 4.2, on methane, why not give the lifetime as stated in the AR5 (4-2 years)? And why does the right-most column ignore the largest mitigation opportunity, which is increasing productivity and production efficiency to reduce enteric methane (at least per unit of product, and it combined with other policies including demand-side, absolute methane emissions)? "Mark Lawrence, Germany"

Take into account. We don't have space to make this table exhaustive. Will revise the heading to include "examples of..." rather than giving the suggestion of comprehensiveness.

7925 31 11 31 12
"Alternatives to IPCC in air-conditioning and refrigeration" are an important part of a much longer list. It needs to create coolth are addressed with the right steps in the right order—all according to ASHRAE's Handbook of Fundamentals—then air conditioning, for example, will cool cool people (not buildings—i.e., deliver "task comfort" like task lighting), then expand the range of comfort conditions by exploiting all comfort variables, then minimize emissions of heat and humidity into the space, then use passive cooling, then near-refrigerative active cooling, and only then efficient and climatically appropriate refrigerative air conditioning (flooded by coo.Storage, controls, maintenance, etc). Thus the table contemplates an improvement in step 8. But doing the five prior steps first can do the entire job cost-effectively anywhere in the world without refrigerative cooling—e.g. with a Pennington cycle (desiccant, regenerating as low as 37°C) or van Zyl cycle. The pre-refrigerative first five steps has indeed been demonstrated to save ~150–100% of air conditioning energy, with equal or better comfort and lower cost, in climates like Bangkok or the central valley of California (Lovins 1995). "Amory Lovins, United States of America"

Take into account. We don't have space to make this table exhaustive. Will revise the heading to include "examples of..." rather than giving the suggestion of comprehensiveness.

7929 31 11 31 12
"Alternatives to IPCC in air-conditioning and refrigeration" are an important part of a much longer list. It needs to create coolth are addressed with the right steps in the right order—all according to ASHRAE's Handbook of Fundamentals—then air conditioning, for example, will cool cool people (not buildings—i.e., deliver "task comfort" like task lighting), then expand the range of comfort conditions by exploiting all comfort variables, then minimize emissions of heat and humidity into the space, then use passive cooling, then near-refrigerative active cooling, and only then efficient and climatically appropriate refrigerative air conditioning (flooded by coostorage, controls, maintenance, etc). Thus the table contemplates an improvement in step 8. But doing the five prior steps first can do the entire job cost-effectively anywhere in the world without refrigerative cooling—e.g. with a Pennington cycle (desiccant, regenerating as low as 37°C) or van Zyl cycle. The pre-refrigerative first five steps has indeed been demonstrated to save ~150–100% of air conditioning energy, with equal or better comfort and lower cost, in climates like Bangkok or the central valley of California (Lovins 1995). "Amory Lovins, United States of America"

Take into account. We don't have space to make this table exhaustive. Will revise the heading to include "examples of..." rather than giving the suggestion of comprehensiveness.

10639 31 11 31 13
"Ozone needs to be added to the table. Also, better references would be the UNEP reports and Shindell papers. "Mark Lawrence, Germany"

Reject. See response to comment 16415.

1475 31 11 31 20
"CH4 as an SLP is given limited coverage in terms of mitigation potential (mainly references to AR5). However, more could be done on emerging sources (e.g. shale and arable exploitation) and their potential for climate emissions in arable agriculture. Likewise, trends in increased meat and dairy production (and so ruminate CH4 emissions) should be highlighted, with the mitigation potential (e.g. livestock management, feed additives, dietary change literature noted). "David Rey, United Kingdom (of Great Britain and Northern Ireland)"

Accept, will take into account with reference to new literature (see references in Shindell et al. 2017).

14126 31 11 31 12
"% SO2 GGE eq prob. should be 15% GGE eq. (Jason Dinnin, Canada)"

Editorial.

1570 31 14 31 14
I suggest to insert here:"Many measures reducing SLCPs have been proposed (UNEP 2011)." - Reference: UNEP 2011. Near-term Climate Protection and Clean Air Benefits: Actions for Controlling Short-Lived Climate Forcers, United Nations Environment Programme (UNEP), Nairobi, Kenya. "Piet Van Vliethoff, Netherlands"

Reject. grey literature of which the insights are also included in more recent, peer-reviewed literature.

15640 31 18
"I suggest that atmospheric impacts of reducing HFCs be included in this table. "Mark Lawrence, Germany"

Accept, see comment 12294.

15641 31 18
"No methane needs to be added to the list of 4.5.2 on co-benefits. "Mark Lawrence, Germany"

Accept, done.

20831 31 22
"Low carb diets: dietary change literature noted. "David Rey, United Kingdom (of Great Britain and Northern Ireland)"

Accept. Reducing agricultural biomass burning to be removed, added Table, now table 4.5 on co-benefits.

10642 31 23
This was extensively discussed in AR5 - the conclusions of that discussion should be summarized here (this is one of the many reasons that this section deserves a longer length allocation). "Mark Lawrence, Germany"

Reject. We have been assigned to update, not summarize, the AR5 here.

16417 31 26 31 27
In that the co-benefits are so important, I would urge further elaborating them here rather than mainly leaving them to references that will make the reader go on an extra effort. "Michael MacCracken, United States of America"

Accept. Although this section is about feasibility of SLCP mitigation measures, a column has been added to Table 4.5 on co-benefits.

760 31 26 31 32
"Hex consideration been given to adding hydrogen to the gasline to ease if it will reduce black carbon? "MacKenzie T. Solar Hydrogen Economy. ISBN 97807575-0-7. Deem that, using hydrogen in small non vehicle engines like lawn mowers, many exhaust emissions are reduced. Mixing hydrogen with gasoline need to be looked into as a mitigating solution for black carbon. "Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)"

Reject. This is a small part of the problem and in 1.5C world, it seems unlikely that gasoline-based lawn mowers will continue to exist.

Taken into account. This article mainly focuses on the role of wireless sensors and is considered for inclusion in section 4.4.4. It is a core reference to the feasibility of modern clean cooking solutions, however, other references will be added on this.

564
31
31
26
26


Taken into account. This article mainly focuses on the role of wireless sensors and is considered for inclusion in section 4.4.4. It is a core reference to the feasibility of modern clean cooking solutions, however, other references will be added on this.

10643
32
32
31
31
35
35
ext references, e.g., Ramasubraman et al., Nature Climate Change, 2017 [http://www.nature.com/articles/nclimate3141.html] [Mark Lawrence, Germany]

Accept. The assessment of CCS has been finalized to be included in the SOD. Furthermore, CCS has been moved to 4.3.2 to focus 4.3.8 on CDR.

14294
31
33
33
31
35
35
Interstate information, should be cited: "Switching from biomass cook stoves to cleaner gas stoves (based on liquefied petroleum gas or natural gas (LPG/NG)) or to electric cooking stoves is technically and economically feasible in most areas, but faces barriers in user preferences, costs, and the organization of supply chains." [Jason Donev, Canada]

Accept. The information deficit should be more clearly characterised as a problem related to institutional feasibility.

13522
32
32
33
32
2
2
Switching from "field burning" to other agricultural practices is mentioned as a measure to reduce the emissions of black carbon. To make it more clear I suggest to change the expression to "field burning of agricultural residues". I also wonder why "field burning of agricultural residues" is not mentioned in table 4.2, since its an important source of black carbon. [Harald Leflettner, Norway]

First part: reject; it's not just agricultural residues that burn on the fields. Second part: accept, will be added [see response to 20831].

10644
32
32
33
32
3
3
This paragraph is so vague that it’s not really useful - again, grounds for increasing the length allocation for this section. [Mark Lawrence, Germany]

Accept, and "for HFCs added"

10449
32
32
33
32
3
3
This paragraph is so vague that it’s not really useful - again, grounds for increasing the length allocation for this section. [Mark Lawrence, Germany]

Accept, and "for HFCs added"

10646
32
4
4
4
Climate-friendly is not a scientific term and has no place in an IPCC report [Mark Lawrence, Germany] Accept. Word will be removed and replaced with "with reduced ability to absorb outgoing longwave radiation"

14399
32
32
32
8
8
Core needs to stay of the shear of 1016 reference - hard to find [William Moomaw, USA, France]

Rejected.

14205
32
8
8
8
Euros or USD? Be consistent. (Hard to do coordinating different authors!) [Jason Donev, Canada]

Accept. Has been revised to USD2010

10647
32
32
32
32
13
13
This paragraph needs to be re-considered and expanded to provide enough information to be sensible and accurate. First, if the section is focusing on warning SLCPs, as indicated in the introduction paragraph on page 30, then it is not correct that there is "a substantial overlap with SLP mitigation strategies", since the overlap is mainly with cooling SLCPs like CO2 (see above). Further, the statement "SLCP reductions may be achieved later..." makes no sense if there is overlap as asserted in the previous sentence - this needs some explanation for the reader to understand what the authors mean and what assumptions this is based on (i.e., again, more space is needed). [Mark Lawrence, Germany]

Accept, will be clarified and better references to: section 2.3 indicates that most very low-emission pathways include a transition away from use of coal and natural gas in the energy sector and oil transportation, leading to a substantial overlap with SLCP mitigation strategies in such scenarios. However, SLCP reductions may be achieved later in such scenarios. [Eleni Kaditi, Austria]

20852
32
32
16
16

Amorim et al. (2012) characterized the air quality benefits on health of SLCP mitigation as well [Johan Carl Ivar Kuylenstierna, United Kingdom (of Great Britain and Northern Ireland)]

Accept. It is a peer-reviewed source so better than Schmale et al, which is a comment.

20852
32
32
17
17
18
18
I think the benefits for energy access, gender equality and poverty eradication apply specifically to cleaner cookstoves, not the other SLCP options? [Alison Smith, United Kingdom (of Great Britain and Northern Ireland)]

Accept. This section will be adjusted to focus on feasibility only rather than compatibility with sustainable development (though the two are of course related, so that link will be made clear).

10648
32
32
16
16

The claim that there is an information deficit is not useful without further explanation of what specific knowledge gaps exist and what are relevant (i.e., it is well known that additional knowledge alone is not enough to steer behavior, otherwise e.g. there would not be any more smokers). Further, this is linked with the "absence of international effort...being a significant barrier..." - this is an interesting hypothesis that might have some merit, but it is unclear to me how these are really connected and needs to be expanded on (or cut) - again, further grounds for increasing the length allocation for the selection. [Mark Lawrence, Germany]

Partly accept. The information deficit should be more clearly characterised as a problem related to institutional feasibility.

10219
32
22
39
39
8
8
A good review of carbon capture etc. I found a lack of assessment though, as the section says I think this all needs pulling together. Paragraphs should not be written as she said/he said - but more critical assessment [Piers Forster, United Kingdom (of Great Britain and Northern Ireland)]

Rejected. The assessment of CCS has been clarified to be included in the SOD. Furthermore, CCS has been moved to 4.3.2 to focus 4.3.8 on CDR.

11167
32
32
23
23

Chapter 2 is clear that the need for NET deployment strongly varies between different socio-economic scenarios and a greatly reduced by stringent near-term mitigation. This is not consistently reflected in this section. [Michiel Schaeffer, Netherlands]

Taken into account - the this has been clarified with chapter 2 and we are using consistent language now. Note however that while near-term mitigation indeed reduces the requirement for NETs in the long term, stringent near-term mitigation can well use NETs to achieve the reduction rates required (in this case, most often land-based measures are considered because they are assumed to scale much faster to considerable levels). In any case, this particular paragraph had to be removed to save space.

19624
32
32
23
23

In the introductory section, it might be good to develop a process or two of the role on the list of CCS more widely, not only the CO2 removal context. This gives the impression that in a 1.5 world only removal is of importance. Some text from the following section (for example from lines 26 to 35 might still be better in an overarching section up front. [Elina Levina, France]

Rejected. As there was duplication with section 4.3.2, the CCS text has been moved there where the role of CCS is introduced more broadly - as suggested. Section 4.3.8 is now only about removal.

20203
32
32
23
23

4.3.8 Removing carbon dioxide from the atmosphere... [Timo Wilkenborg, Netherlands]

Accepted - see reply to comment 19694

13064
32
32
32
23
23
Removal should be added in the title, changing to "Removal of carbon dioxide for the atmosphere..." [Cesare Stefanof, Italy]

Accepted. "removal" added to the title, which furthermore had to be shortened - thereby also addressing comments 13565 and 20203.

19699
32
32
32
45
45
In the introductory section, it might be good to develop a process or two of the role on the list of CCS more widely, not only the CO2 removal context. This gives the impression that in a 1.5 world only removal is of importance. Some text from the following section (for example from lines 26 to 35 might still be better in an overarching section up front. [Elina Levina, France]

Rejected. As there was duplication with section 4.3.2, the CCS text has been moved there where the role of CCS is introduced more broadly - as suggested. Section 4.3.8 is now only about removal.
Even at current scale, biotech and biorecovery are not scaling at the level needed to achieve the 2.5°C target. We would need a large scale combination of both technologies to achieve the necessary negative emissions. The current policy and research focus is on small scale deployment of negative emissions technologies, which are not sufficient to achieve the required negative emissions. It is imperative that a clear distinction be made between long term CCS, and use of captured CO2 for enhanced oil recovery (EOR). It is clearly not a realistic strategy for emissions mitigation to capture CO2 and then use it to access oil/gas from depleted wells! There is much obfuscation on this matter, with confusion about the terminology (CCS often referring to EOR). Oil industry estimates that about 30% of CO2 injected at an EOR site will be directly emitted back into the atmosphere. That could be an underestimate, and does not even include assessment of the parasitic load associated with the EOR process. This means much more CO2 must, in turn, be captured (and stored) since it takes energy to do capture this parasitic load into account. Please note that the parasitic load issue is discussed (and was already the case in the FGG) in the DACCS section as well. We did not find any discussion of the parasitic energy load requirements associated with carbon capture for BECCS. (It is mentioned for fossil CCS). Capture of CO2 from biomass emissions would be much more challenging even than from fossil fuels due to the low energy efficiency and low energy density of bioenergy. Please note that the parasitic load is assessed for all energy generated. (See http://www.pfpi.net/carbon-emissions) This means much more CO2 must, in turn, be captured and stored. Since it takes energy to do capture this parasitic load, much higher overall parasitic energy demand, and much more biomass emissions would be required. Global CCS Institute estimates that capturing CO2 from a 78 MW biomass power station that would otherwise have a capture efficiency of 35% would reduce the electricity output to just 49 MW, reducing efficiency to just 22%. REF: https://www.globalccsinstitute.com/publications/biomass-ccs-study [Oliver Smolker, United States of America].

It is imperative that a clear distinction be made between large scale BECCS and use of captured CO2 for enhanced oil recovery (EOR). As with CCS from fossil fuels, the economic considerations of BECCS will be highly dependent on the cost of CO2 capture and the efficiency of the BECCS process. It is clear that the parasitic load issue is discussed (and was already the case in the FGG) in the DACCS section as well. We did not find any discussion of the parasitic energy load requirements associated with carbon capture for BECCS. (It is mentioned for fossil CCS). Capture of CO2 from biomass emissions would be much more challenging than from fossil fuels due to the low energy efficiency and low energy density of bioenergy. Please note that the parasitic load is assessed for all energy generated. (See http://www.pfpi.net/carbon-emissions) This means much more CO2 must, in turn, be captured and stored. Since it takes energy to do capture this parasitic load, much higher overall parasitic energy demand, and much more biomass emissions would be required. Global CCS Institute estimates that capturing CO2 from a 78 MW biomass power station that would otherwise have a capture efficiency of 35% would reduce the electricity output to just 49 MW, reducing efficiency to just 22%. REF: https://www.globalccsinstitute.com/publications/biomass-ccs-study [Oliver Smolker, United States of America].

We did not find any discussion of the parasitic energy load requirements associated with carbon capture for BECCS. (It is mentioned for fossil CCS). Capture of CO2 from biomass emissions would be much more challenging than from fossil fuels due to the low energy efficiency and low energy density of bioenergy. Please note that the parasitic load is assessed for all energy generated. (See http://www.pfpi.net/carbon-emissions) This means much more CO2 must, in turn, be captured and stored. Since it takes energy to do capture this parasitic load, much higher overall parasitic energy demand, and much more biomass emissions would be required. Global CCS Institute estimates that capturing CO2 from a 78 MW biomass power station that would otherwise have a capture efficiency of 35% would reduce the electricity output to just 49 MW, reducing efficiency to just 22%. REF: https://www.globalccsinstitute.com/publications/biomass-ccs-study [Oliver Smolker, United States of America].

It is imperative that a clear distinction be made between large scale BECCS and use of captured CO2 for enhanced oil recovery (EOR). It is clearly not a realistic strategy for emissions mitigation to capture CO2 and then use it to access oil/gas from depleted wells! There is much obfuscation on this matter, with confusion about the terminology (CCS often referring to EOR). Oil industry estimates that about 30% of CO2 injected at an EOR site will be directly emitted back into the atmosphere. That could be an underestimate, and does not even include assessment of the parasitic load associated with the EOR process. This means much more CO2 must, in turn, be captured (and stored) since it takes energy to do capture this parasitic load into account. Please note that the parasitic load issue is discussed (and was already the case in the FGG) in the DACCS section as well. We did not find any discussion of the parasitic energy load requirements associated with carbon capture for BECCS. (It is mentioned for fossil CCS). Capture of CO2 from biomass emissions would be much more challenging even than from fossil fuels due to the low energy efficiency and low energy density of bioenergy. Please note that the parasitic load is assessed for all energy generated. (See http://www.pfpi.net/carbon-emissions) This means much more CO2 must, in turn, be captured and stored. Since it takes energy to do capture this parasitic load, much higher overall parasitic energy demand, and much more biomass emissions would be required. Global CCS Institute estimates that capturing CO2 from a 78 MW biomass power station that would otherwise have a capture efficiency of 35% would reduce the electricity output to just 49 MW, reducing efficiency to just 22%. REF: https://www.globalccsinstitute.com/publications/biomass-ccs-study [Oliver Smolker, United States of America].

We did not find any discussion of the parasitic energy load requirements associated with carbon capture for BECCS. (It is mentioned for fossil CCS). Capture of CO2 from biomass emissions would be much more challenging than from fossil fuels due to the low energy efficiency and low energy density of bioenergy. Please note that the parasitic load is assessed for all energy generated. (See http://www.pfpi.net/carbon-emissions) This means much more CO2 must, in turn, be captured and stored. Since it takes energy to do capture this parasitic load, much higher overall parasitic energy demand, and much more biomass emissions would be required. Global CCS Institute estimates that capturing CO2 from a 78 MW biomass power station that would otherwise have a capture efficiency of 35% would reduce the electricity output to just 49 MW, reducing efficiency to just 22%. REF: https://www.globalccsinstitute.com/publications/biomass-ccs-study [Oliver Smolker, United States of America].

It is imperative that a clear distinction be made between large scale BECCS and use of captured CO2 for enhanced oil recovery (EOR). It is clearly not a realistic strategy for emissions mitigation to capture CO2 and then use it to access oil/gas from depleted wells! There is much obfuscation on this matter, with confusion about the terminology (CCS often referring to EOR). Oil industry estimates that about 30% of CO2 injected at an EOR site will be directly emitted back into the atmosphere. That could be an underestimate, and does not even include assessment of the parasitic load associated with the EOR process. This means much more CO2 must, in turn, be captured (and stored) since it takes energy to do capture this parasitic load into account. Please note that the parasitic load issue is discussed (and was already the case in the FGG) in the DACCS section as well. We did not find any discussion of the parasitic energy load requirements associated with carbon capture for BECCS. (It is mentioned for fossil CCS). Capture of CO2 from biomass emissions would be much more challenging even than from fossil fuels due to the low energy efficiency and low energy density of bioenergy. Please note that the parasitic load is assessed for all energy generated. (See http://www.pfpi.net/carbon-emissions) This means much more CO2 must, in turn, be captured and stored. Since it takes energy to do capture this parasitic load, much higher overall parasitic energy demand, and much more biomass emissions would be required. Global CCS Institute estimates that capturing CO2 from a 78 MW biomass power station that would otherwise have a capture efficiency of 35% would reduce the electricity output to just 49 MW, reducing efficiency to just 22%. REF: https://www.globalccsinstitute.com/publications/biomass-ccs-study [Oliver Smolker, United States of America].

We did not find any discussion of the parasitic energy load requirements associated with carbon capture for BECCS. (It is mentioned for fossil CCS). Capture of CO2 from biomass emissions would be much more challenging than from fossil fuels due to the low energy efficiency and low energy density of bioenergy. Please note that the parasitic load is assessed for all energy generated. (See http://www.pfpi.net/carbon-emissions) This means much more CO2 must, in turn, be captured and stored. Since it takes energy to do capture this parasitic load, much higher overall parasitic energy demand, and much more biomass emissions would be required. Global CCS Institute estimates that capturing CO2 from a 78 MW biomass power station that would otherwise have a capture efficiency of 35% would reduce the electricity output to just 49 MW, reducing efficiency to just 22%. REF: https://www.globalccsinstitute.com/publications/biomass-ccs-study [Oliver Smolker, United States of America].

It is imperative that a clear distinction be made between large scale BECCS and use of captured CO2 for enhanced oil recovery (EOR). It is clearly not a realistic strategy for emissions mitigation to capture CO2 and then use it to access oil/gas from depleted wells! There is much obfuscation on this matter, with confusion about the terminology (CCS often referring to EOR). Oil industry estimates that about 30% of CO2 injected at an EOR site will be directly emitted back into the atmosphere. That could be an underestimate, and does not even include assessment of the parasitic load associated with the EOR process. This means much more CO2 must, in turn, be captured (and stored) since it takes energy to do capture this parasitic load into account. Please note that the parasitic load issue is discussed (and was already the case in the FGG) in the DACCS section as well. We did not find any discussion of the parasitic energy load requirements associated with carbon capture for BECCS. (It is mentioned for fossil CCS). Capture of CO2 from biomass emissions would be much more challenging even than from fossil fuels due to the low energy efficiency and low energy density of bioenergy. Please note that the parasitic load is assessed for all energy generated. (See http://www.pfpi.net/carbon-emissions) This means much more CO2 must, in turn, be captured and stored. Since it takes energy to do capture this parasitic load, much higher overall parasitic energy demand, and much more biomass emissions would be required. Global CCS Institute estimates that capturing CO2 from a 78 MW biomass power station that would otherwise have a capture efficiency of 35% would reduce the electricity output to just 49 MW, reducing efficiency to just 22%. REF: https://www.globalccsinstitute.com/publications/biomass-ccs-study [Oliver Smolker, United States of America].

We did not find any discussion of the parasitic energy load requirements associated with carbon capture for BECCS. (It is mentioned for fossil CCS). Capture of CO2 from biomass emissions would be much more challenging than from fossil fuels due to the low energy efficiency and low energy density of bioenergy. Please note that the parasitic load is assessed for all energy generated. (See http://www.pfpi.net/carbon-emissions) This means much more CO2 must, in turn, be captured and stored. Since it takes energy to do capture this parasitic load, much higher overall parasitic energy demand, and much more biomass emissions would be required. Global CCS Institute estimates that capturing CO2 from a 78 MW biomass power station that would otherwise have a capture efficiency of 35% would reduce the electricity output to just 49 MW, reducing efficiency to just 22%. REF: https://www.globalccsinstitute.com/publications/biomass-ccs-study [Oliver Smolker, United States of America].
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
14350 | 32 | 28 | 32 | 29 | This would require an evaluation of the social and economic aspects of CO2S if used at an industrial scale. While reducing GHG emissions is primordial, the process cannot rely on a tool that might open new concerns. ([Yana Porfir'eva, Tovar, France]) | Taken into account - see reply to comment 20585
7955 | 32 | 30 | 33 | 33 | Chapter 2 mentions only BECCS and AR as included in the pathway! [Jaerem Kemper, United Kingdom (of Great Britain and Northern Ireland)] | Rejected - Although there are only a few studies with direct air capture, chapter 2 does assess these in their report. It also comments 7955 and 4304. In any case, this part of the text is gone due to serious shortening.
7917 | 32 | 31 | 35 | On-diesel cleaning, the tone is pessimistic. There are no reliable figures for diesel cleaning in Sub-Saharan Africa that show promise. Also some countries already have done tremendous. But scaling up diesel cleaning like LPG, see Braathen et al. 2017. Powering Cities in the Global South: How Energy Access for All Benefits the Economy and the Environment. World Resources Institute (Washington, D.C., United States of America) | Taken into account, however, the reference is grey literature and therefore cannot be used.
4304 | 32 | 32 | This reference to direct air capture is incorrect. According to the colour code adopted in Chapter 2, page 36, Table 2.5, DACS (in yellow) has not been included in any of the scenarios/pathways reviewed in the report, perhaps because its prohibitive cost compared against BECCS? ([Alanates Cartol, Spain]) | Rejected - Although there are only a few studies with direct air capture, chapter 2 does assess these in their report. Yellow" in the table referred to here indicates that it is included in some of the models and it is not clear whether it could be an option. (Jaerem Manger, Norway, France)
9449 | 32 | 32 | 32 | Key (DACCS) to DACS and add "order" for direct air capture and storage. So it will be easy to grasp that it is associated with CCS. There are different categories of CCS; fossil CCS, industry CCS (terminology used in Chapter 2, BECCS and DACCS, depending on where the CO2 is captured from, (Isabelle Czernichowski-Lauriol, France) | Accepted and coordinated with chapter 2 (see also comment 19324)
6755 | 33 | 33 | 36 | Once again the term 'option' is used here to describe a range of proposed CDR concepts in the context of model assumptions, but referring to them as 'options' could easily lead to misinterpretations of that context. They are, in many cases, merely proposed concepts. Use of the term 'option' should be restricted to much more specific contexts throughout the report in order to avoid giving the false impression that all proposed CDR techniques represent options in policy terms. In the specific case of ocean fertilisation, this is not even a legally or politically acceptable option as decisions have already been taken at an international level to prohibit the technique other than for legitimate scientific research (for details of Resolutions and amendments under the London Convention and Protocol, see http://www.incois.org/OurWork/Environment/COP/InstitutingChanges/Institute/gyellowing/Pages/default.aspx). Other proposed marine CDR techniques have yet to be given the detailed scientific and policy critique that would be needed in order to determine whether or not they can ever be considered to be options. ([Marco Mazzotti, Switzerland]) | Taken into account - In the (new) final paragraph, text has been added to again highlight that the different options are at different stages of technological readiness, a result that also comes from the assessment. We do by no means prescribe the implementation of any options and maintain full transparency about their uncertainties. (see also comment 6756)
9460 | 32 | 41 | 42 | Replace the sentence by: Another option of options assessed here concerns the utilisation of carbon captured from air or bioenergy plants. Don’t mention here COUS which is much wider, as includes also capture from power and industrial plants as well as storage. (Isabelle Czernichowski-Lauriol, France) | Taken into account - In fact, the mandate for this section is to cover CCUS in addition to CDR. The difference between CCUS from direct air capture or bioenergy and fossil CCS has now been clarified with an additional sentence. (See also comments 7955, 7958, 14130 and 19232). CCUS is assessed in section 4.3.2 now.
7343 | 32 | 41 | 42 | Delete the text "In the absence of carbon pricing, the argument is that". ([Eleni Kaditi, Austria]) | Taken into account - This paragraph has been removed and a more balanced discussion is offered further below. (see also comments 9450, 14130 and 4305).
7956 | 32 | 41 | 45 | Very thin ice. There is no sufficient proof yet that the options mentioned result in net negative emissions. One point of debate is whether fossil carbon captured and stored can ever be genuinely net negative. You also picked options as examples that are amongst the ones likely not resulting in negative emissions, due to the lack of permanence of carbon storage. Better example would have been carbonated minerals. The paragraph also somewhat contradicts the more balanced argumentation in 4.3.6.7, p.481, BR, on this topic. ([Jaerem Kemper, United Kingdom (of Great Britain and Northern Ireland)]) | Taken into account - This paragraph has been removed and a more balanced discussion is offered further below. (see also comments 9450, 14130 and 4305).
19232 | 32 | 41 | 45 | This is very controversial and questionable, and should not be presented without critical comment. ([Marco Mazzotti, Switzerland]) | Taken into account - see comments 7955, 7956. This is an introductory sentence has been deleted and the (critical) discussion follows further down in the main text.
4305 | 33 | 33 | 45 | This paragraph is mixing/confusing two different CDR options. The text on EOR (which can be considered an option for CO2 geological storage if/whe a net flow of CO2 is permanently stored underground) could be more clearly stated with text from CO2, to the reader, the lifetime of the carbon product is very short and the potential mitigation merits rely on the renewable energy used for its utilization (see IPCC SR Ch 7, [2007]) (Alanates Cartol, Spain) | Taken into account - This was meant to be a list of CDR options without saying they have the same effectiveness. The assessment shows that neither will likely contribute much to climate change mitigation. The options have been removed and CCUS is discussed as a concept now. (see also comments 9450, 7958, 14130 and 19232).
14130 | 32 | 43 | 45 | Suggest use synthetics fuel rather than synthetics for non specialist reader [Elena Pulczarska, Germany] | Noted - the text has been removed.
9451 | 32 | 43 | 43 | Add briefly why the technology does not per se lead to negative emissions. ([Isabelle Czernichowski-Lauriol, France]) | Taken into account - This is a very controversial and questionable, and should not be presented without critical comment.
11186 | 32 | 48 | 48 | The potential benefits of bioenergy should be considered somewhere (also relevant for chapter 3). E.g. from Creutzig et al. 2014: "uncertainty about projections should not preclude pursuing beneficial bioenergy options" ([Michael Schaeffer, Netherlands]) | Taken into account - see comments 9450, 7958. This is an introductory sentence has been deleted and the (critical) discussion follows further down in the main text.
4877 | 32 | 48 | 48 | Separate 4.3.6.1 into two sections. A carbon capture and storage (for power and industry) and a Bioenergy with carbon capture and storage ones. With inclusion of the dependencies/ synergies between CCS in different sectors/applications ([Will Haas, Netherlands]) | Taken into account - ACCS has been moved to section 4.3.2.
20323 | 32 | 48 | 48 | With bioenergy being considered a limiting resource, one could mention that technology approaches, that use the CO2 from BECCS together with hydrogen from renewable electricity to produce gaseous or liquid synfuels, allow the bioenergy carbon to be used twice for energy purposes, maximising the energy use from the limited bioenergy resources. ([Marine Gomer, France]) | Taken into account - text has been added in footnote #5. See also comment 4877.
11038 | 32 | 48 | 48 | Land-use implications of BECCS (or terrestrial CDR as a whole) have to be scrutinized in this subchapter, including the IAM assumption that the conversion of pasture would be the major source for land then devoted to delivering biomass for CDR. Real world experiences should be taken into account when assessing the process of land-use transitions (see Bock 2016: Rapid scale-up of negative emissions technologies: social barriers and implementation ([Oliver Geden, Germany]) | Taken into account - This was meant to be a list of CDR options without saying they have the same effectiveness. The assessment shows that neither will likely contribute much to climate change mitigation. The options have been removed and CCUS is discussed as a concept now. (see also comments 9450, 7958, 14130 and 19232).
5130 | 32 | 48 | 30 | The discussion of BECCS would benefit greatly from more discussion of the social feasibility of this approach, particularly in the context of hunger, food security, land rights, etc. Because of the high levels of concern about BECCS, consideration of these issues in the report will ensure that the discussion is not set aside entirely by civil society actors, because of a lack of discussion of these issues. If there are research gaps around these issues, these should be emphasized. ([Tonya Rawe, United States of America]) | Taken into account - see comments 9450, 7958, 14130 and 19232. CCUS is assessed in section 4.3.2 now.
20113 32 48 34 30 The section discusses the main potential to BECCS (bio-physical limitations to bioenergy potentials, land requirements, impact on food production, ecosystems and biodiversity, energy and water intensity and storage capacity, required infrastructure, uncertainties around timely scaling-up as a potential to CCS, as well as limited public acceptance of large-scale BECCS). The section also addresses double over the alleged carbon neutrality of bioenergy and the increase in competition for resources like land and water. These risks and uncertainties cannot be understated, and cannot be mitigated through pathways as proposed by IANs in Chapter 2, unless repositioned in BECCS in great measure. Chapter 4 authors must make sure that Chapter 2 authors produce mitigation pathways that are pertinent to the serious concerns voiced here. [Jürg Bures, Germany] Rejected - Chapter 2 does not propose their own pathways. They can only assess what is in the literature. See also comments 11098, 20113, 2702.

20533 32 48 34 30 It seems that BECCS is over-emphasized in relation to other options. The diversity of mitigation options need to be covered and trade-offs clearly identified in a balanced discussion. [Hans Poerster, Germany] Taken into account - The BECCS paragraph has been shorten significantly by outsourcing bioenergy to 4.3.3 and CCS 4.3.2. By including an extra paragraph, the whole text of 4.3.8 could be reduced in comparison to 4.3.1-4.3.7.

2248 32 48 34 30 The section does not address the challenge embedded in large-scale deployment of BECCS in 2000 (12 years from now). Early opportunities for BECCS have been identified by B. Ståhl and K. Y. Yan (2001). Potential market niches for biomass energy with CO2 capture and storage - Opportunities for energy supply with negative CO2 emissions. Biomass and Bioenergy 25 (3) 273-285, as noted in previous IPCC reports (SR CCS and AR4). [Kenneth Möllersten, Sweden] Taken into account - The assessment has been completed only after the FOD. As the upscaling challenge is not typical for BECCS only, there is now a general paragraph at the end of the section discussing these issues for the wider set of CDR options.

20432 32 48 34 30 The Section on BECCS seems out of balance with the rest of the options. The long section of the length one is one reason. Another reason is BECCS is essentially a combination of technologies and the component technologies are addressed elsewhere. The last reason is that other combinations, or suites of approaches, are not addressed. At a minimum, it should be said that BECCS is one combination of technology, but there are various combinations of technologies and approaches that could potentially be used to address climate change but BECCS just happens to have more early stage literature published while others combinations are yet to be explored and published. [Jeremy Wiles, United Kingdom (of Great Britain and Northern Ireland)] Taken into account - A very valid point. The individual technologies CCS and bioenergy have been moved to sections 4.3.2 and 4.3.3 and we now make clear that we here only assess the BECCS combination, see also comments 20432, 928, 20383. The amount of literature is now reflected in a new Figure that synthesizes the information for all CDR options.

2702 32 48 34 30 For the moment saying that BECCS is only a natural backstop technology that enables the IAM models to achieve a 1.5°C pathway? All of the models involved and this technology arrives on the scene after 2050 to save the day? In addition in all of the double re-iterated in this section, BECCS would need large subsidies to cover the cost of the CCS and because the electricity generated would be more expensive than from solar and wind. The CCS comments here are a little weaker than on page 26. Most of the BECCS plants would be needed for less than 50 years thus making the technology more costly. Revenue from enhanced oil recovery is no longer available because that has effectively phased out. [Eric Harries, Canada] Taken into account - The mandate of the section is to paint an assessment, not to state opinions. The elements mentioned in the comment have been fairly assessed, resulting in a critical view. It is furthermore warned that BECCS suddenly appears after 2050, see pathways in chapter 2, that show that BECCS (or better, a portfolio of CDR options) will need to start being deployed in the first half of the century (though not visible when only consulting visualisations of net emissions). Footnote #1 has been added to avoid this misunderstanding in the SOD.

1084 32 48 34 33 A general comment: I do not recall seeing a deep dive into Global Warming Potential and its relevance for the assumption Bio-energy emissions are neutral. Under an accounting perspective if the right timeframe are used to estimate impacts as related with specific sources. However the domain effect of emissions while in the atmosphere are to be considered as well and those are not neutral at all. Currently this is matter for intense debate e.g. in the EU. [Ivanka aguer-arenas/ersoec, United States of America] Taken into account - there are more reasons why bioenergy might not be carbon-neutral and we can’t provide a deep-dive into all of them. We have added the description about Global Warming Potential of biogenic CO2 emissions to the examples of why bioenergy may not be carbon-neutral in the main text. Note that the bioenergy assessment has been passed to the APOU section, 4.3.3 to discuss this issue more generally. See also comment 1005.

938 32 49 32 49 BECCS receives a huge section in the paper, but on the larger scale is a small component of the climate solution. I think the attention given to the subject is disproportionate and its focus should be diminished. [Elizabeth Aldrich, United States of America] Taken into account - The individual technologies CCS and bioenergy have been moved to sections 4.3.2 and 4.3.3 and we now make clear that we here only assess the BECCS combination, see also comments 20432, 928, 20383. The amount of literature is now reflected in a new Figure that synthesizes the information for all CDR options.

7918 32 49 32 30 The 1.5°C pathways assessed in Chapter 2 remove about 5Gt CO2 per year mid-century. However, currently we have 14 sites with 1 Mt CO2 per year. So we need to scale this up four fold by 2050. How feasible is it to do this? This is not obvious from the results in Section 4.3.8 on emphasizing feasibility. This is a different issue from one of potential. If BECCS unit costs vary widely in the literature, ranging between US$ 20-200 per ton of CO2, how feasible is it that BECCS will wake up in the near term, given that carbon prices currently are much lower than this? [Winfried Michael, United States of America] Taken into account - the feasibility assessment had not been finished prior to the FOD deadline. We now include the full assessment, including references (see Nemet et al.) into the upcoming challenge (see also comments 2248, 7918). See new paragraph at the end of the section discussing these issues for the wider set of CDR options.

7344 32 51 32 51 What is a "long time"? [Kenneth Möllersten, Sweden] Accepted - has been reformulated.

7246 32 51 32 54 The contribution in pathways prior to 2050 is modest (chapter 2 explains that there are substantial negative emissions as soon as 2030) [Kenneth Möllersten, Sweden] Accepted - it is mentioned now, see also footnote #1.

7234 32 54 32 55 Describe the text “Note that bioenergy (Section 4.3.4) can play an even larger role when BECCS is constrained, as biofuels are then needed at scale. [Elizabeth Aldrich, United States of America] Noted - this part of the text no longer exists, as we had to shorter the BECCS subsection.

7907 32 54 33 1 However, finding BECCS in focus in biofuels without CCS does nothing to help with the land demand issues. [Jaakom Kemper, United Kingdom (of Great Britain and Northern Ireland)] Noted - pointing this out was the purpose of the sentence. However, it has been removed due to space constraints and to avoid further misunderstandings.

7831 32 55 33 1 Not with available and cost-effective vehicle efficiency, mobility or freight system efficiency, and hydrogen options, as described in my previous comments. [Amory Lovins, United States of America] Noted - this part of the text no longer exists, as we had to shorter the BECCS subsection. See also comments 7448, 7907.

9376 32 55 33 1 Not with available and cost-effective vehicle efficiency, mobility or freight system efficiency, and hydrogen options, as described in my previous comments. [Amory Lovins, United States of America] Noted - this part of the text no longer exists, as we had to shorter the BECCS subsection. See also comments 7448, 7907.

9121 33 1 33 1 There is a paper Lo et al. (under review) which shows macroeconomic costs under 1.5 degree sceanrio can be reduced if BECCS is more accelerated and its focus should be diminished. [Elizabeth Aldrich, United States of America] Accepted - has been added along with Muratori et al. 2016 on the same topic.

7345 33 3 33 10 The following reference may be also helpful for this paragraph: DOI 10.1007/s10645-012-1074-6 [Osmian Beyran, Austria] Accepted - reference has been incorporated.

565 33 3 33 3 The section on bioenergy and BECCS says nothing about the potential air pollution impact of bioenergy or the fact that photosynthesis is only 1% efficient, or that material emissions from soils (e.g. nitrous oxide) can be as high as 3Gt CO2. Furthermore, bioenergy is not a carbon-neutral solution. [Robledo-Abad et al. 2016, which covers over 1000 articles on bioenergy side effects), see also comments 938, 7918. Accepted - has been reformulated.

9237 33 3 33 3 The section discusses the main potential to BECCS (bio-physical limitations to bioenergy potentials, land requirements, impact on food production, ecosystems and biodiversity, energy and water intensity and storage capacity, required infrastructure, uncertainties around timely scaling-up as a limitation to CCS, as well as limited public acceptance of large-scale BECCS). The section also addresses double over the alleged carbon neutrality of bioenergy and the increase in competition for resources like land and water. These risks and uncertainties cannot be understated, and cannot be mitigated through pathways as proposed by IANs in Chapter 2, unless repositioned in BECCS in great measure. Chapter 4 authors must make sure that Chapter 2 authors produce mitigation pathways that are pertinent to the serious concerns voiced here. [Jürg Bures, Germany] Rejected - Chapter 2 does not propose their own pathways. They can only assess what is in the literature. See also comments 11098, 20113, 2702.

565 33 3 33 3 The section on bioenergy and BECCS says nothing about the potential air pollution impact of bioenergy or the fact that photosynthesis is only 1% efficient, or that material emissions from soils (e.g. nitrous oxide) can be as high as 3Gt CO2. Furthermore, bioenergy is not a carbon-neutral solution. [Robledo-Abad et al. 2016, which covers over 1000 articles on bioenergy side effects), see also comment 5128. Land footprints are now given in Box 3.11.
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>14266</td>
<td>33</td>
<td>3</td>
<td>33</td>
<td>3</td>
</tr>
<tr>
<td>20410</td>
<td>33</td>
<td>3</td>
<td>33</td>
<td>4</td>
</tr>
<tr>
<td>5128</td>
<td>33</td>
<td>7</td>
<td>33</td>
<td>10</td>
</tr>
<tr>
<td>13305</td>
<td>33</td>
<td>12</td>
<td>33</td>
<td>18</td>
</tr>
<tr>
<td>4963</td>
<td>33</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4039</td>
<td>33</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7958</td>
<td>33</td>
<td>16</td>
<td>33</td>
<td>18</td>
</tr>
<tr>
<td>10354</td>
<td>33</td>
<td>20</td>
<td>33</td>
<td>34</td>
</tr>
<tr>
<td>5129</td>
<td>33</td>
<td>20</td>
<td>33</td>
<td>28</td>
</tr>
<tr>
<td>7959</td>
<td>33</td>
<td>24</td>
<td>33</td>
<td>28</td>
</tr>
<tr>
<td>14267</td>
<td>33</td>
<td>27</td>
<td>33</td>
<td>27'</td>
</tr>
<tr>
<td>6756</td>
<td>33</td>
<td>30</td>
<td>33</td>
<td>32</td>
</tr>
<tr>
<td>2247</td>
<td>33</td>
<td>30</td>
<td>33</td>
<td>34</td>
</tr>
<tr>
<td>6092</td>
<td>33</td>
<td>31</td>
<td>33</td>
<td>34</td>
</tr>
<tr>
<td>11065</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>14366</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>36</td>
</tr>
<tr>
<td>4957</td>
<td>33</td>
<td>36</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>7960</td>
<td>33</td>
<td>36</td>
<td>33</td>
<td>38</td>
</tr>
<tr>
<td>3619</td>
<td>33</td>
<td>36</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>20014</td>
<td>33</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11163</td>
<td>33</td>
<td>36</td>
<td>33</td>
<td>4</td>
</tr>
</tbody>
</table>

**Comment**

The 100 EJ for biofuels needs to be put into some sort of context here (I know how much energy the world uses, this is about 20% of current demand, but the normal reader of this section may not). Also, it is consistent with chapter 27 [Jones Donen, Canada]

**Response**

- Noted - the bioenergy paragraph has been moved to 4.3.3. Please note that many IAMs used in chapter 2 partially assume higher than 100 EJ availability, as stated after the references in the sentence (now gone from 4.3.6).
- The following special volume is of interest for this section:

  "International Journal of Greenhouse Gas Control":

  - CCS on page 20 [Stewart Fast, Canada]

  - CCS Projects. [Jasmin Kemper, United Kingdom (of Great Britain and Northern Ireland)]

  - CCS Assessment of capacity and potential. [Isaac Knapton, United Kingdom (of Great Britain and Northern Ireland)]

  - CCS Assessment of capacity and potential. [Isaac Knapton, United Kingdom (of Great Britain and Northern Ireland)]

- Noted - this is why more geographically explicit studies of BECCS potentials are identified as a key knowledge gap, see also section 4.5.1. But more specifically, the context with respect to arable land is given. However, we cannot go into this much detail as requested by the comment, as we had to cut the BECCS section substantially and the discussion is therefore more high-level now. See also comment 10534.

- Accepted - there are additional studies on BECCS potentials and more wider context with respect to global freshwater withdrawals (2016 km^3 according to the United Nations World Water Development Report 2017).

- Accepted - but could not find anything peer-reviewed on this.

- Noted - however this text no longer exist, as we had to shorten the BECCS part of the section.

- Noted - this is why more geographically explicit studies of BECCS potentials are identified as a key knowledge gap, see also section 4.5.1. But more specifically, the context with respect to arable land is given. However, we cannot go into this much detail as requested by the comment, as we had to cut the BECCS section substantially and the discussion is therefore more high-level now. See also comment 10534.

- Noted - please use the original references cited in the text.

- Noted - the bioenergy paragraph has been moved to section 4.3.3. Please note that many IAMs used in chapter 2 partially assume higher than 100 EJ availability, as stated after the references in the sentence (now gone from 4.3.6).

- Noted - this is why more geographically explicit studies of BECCS potentials are identified as a key knowledge gap, see also section 4.5.1. But more specifically, the context with respect to arable land is given. However, we cannot go into this much detail as requested by the comment, as we had to cut the BECCS section substantially and the discussion is therefore more high-level now. See also comment 10534.

- Noted - please use the original references cited in the text.

- Noted - please use the original references cited in the text.

- Accepted - there are additional studies on BECCS potentials and more wider context with respect to global freshwater withdrawals (2016 km^3 according to the United Nations World Water Development Report 2017).

- Accepted - but could not find anything peer-reviewed on this.

- Noted - please use the original references cited in the text.

- Accepted - there are additional studies on BECCS potentials and more wider context with respect to global freshwater withdrawals (2016 km^3 according to the United Nations World Water Development Report 2017).

- Accepted - but could not find anything peer-reviewed on this.

- Noted - please use the original references cited in the text.

- Accepted - there are additional studies on BECCS potentials and more wider context with respect to global freshwater withdrawals (2016 km^3 according to the United Nations World Water Development Report 2017).

- Accepted - but could not find anything peer-reviewed on this.
The section on CCS says nothing about the fact that CCS requires 25% more energy to run the CCS equipment, thus 25% more mining and transport of coal or gas, plus 35% more air pollution, since CCS diminishes mining or transport or air emissions aside from CO2 from the smokestack. Since mining and transport are around 1/3 of the emissions, coal-CCS, for example, results in 50 times more CO2 than wind per unit energy and 100 times more air pollution (see, for example, 40; Jacobson, M.Z.; Review of evidence for global warming, air pollution, and energy security, Energy & Environmental Science, 2, 148-173, doi:10.1039/b809990c, 2009) [Mark Jacobson, United States of America].

Note - These parameters are taken into account in the modeling referred to here and the CCS assessment has been moved to section 4.3.2, where it is discussed in more detail, see also comment 6757.

Note - This test is gone from this section due to (a) the CCS assessment having moved to 4.3.2 and (b) aware shortening of the BECCS paragraph for space-saving and balancing reasons.
Comment No | From Page | From Line | To Page | To Line
--- | --- | --- | --- | ---
18791 | 34 | 18 | 34 | 30
18824 | 34 | 18 | 34 | 30
6793 | 34 | 18 | 34 | 30
7961 | 34 | 19 | 34 | 20
7940 | 34 | 19 | 34 | 20
14515 | 34 | 20 | 34 | 34
16418 | 34 | 22 | 34 | 23
20370 | 34 | 22 | 34 | 23
7962 | 34 | 22 | 34 | 24
7892 | 34 | 25 | 34 | 30
1095 | 34 | 25 | 34 | 28
7928 | 34 | 25 | 34 | 30
14363 | 34 | 28 | 34 | 28
7983 | 34 | 28 | 34 | 30
1729 | 34 | 28 | 34 | 29
11000 | 34 | 33 | 34 | 33
1395 | 34 | 19 | 34 | 19

Comment
References concerning impacts of BECCS on land use and food should also include Searchinger, T. and R. Heinrich. 2015. Avoiding Bioenergy Competition for Food and Land.’ Working Paper, installment 9 of Creating a Sustainable Future, Washington, DC: World Resources Institute. Available online at http://www.worldresourcesinstitute.org [David Waskow, United States of America] (Taken into account - in the main text we use the peer-reviewed Searchinger paper. Searchinger and Heinrich are addressed in Box 4.3.)

References concerning impacts of BECCS on land use and food should also include Searchinger, T. and R. Heinrich. 2015. Avoiding Bioenergy Competition for Food and Land.’ Working Paper, installment 9 of Creating a Sustainable Future, Washington, DC: World Resources Institute. Available online at http://www.worldresourcesinstitute.org [David Waskow, United States of America] (Taken into account - in the main text we use the peer-reviewed Searchinger paper. Searchinger and Heinrich are addressed in Box 4.3.)

They fail to mention the water impact of BECCS and how that can have a range of impacts, especially in light of climate change. See Smith et al. 2016. The also impacts the feasibility of CCS operation. We should not lose sight of the fact that existing land and water resources are already stressed in many parts of the world and are only becoming more stressed. See, e.g., Alemayehu, N. and Hurne, J. (2012) World Agriculture towards 2030/2050: The 2012 Review. ESA Working Paper 12-03. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/docrep/019/a0701e/a0701e.pdf. One uncertainty is, for instance, the water requirements of different bioenergy crops in a warming world. See, e.g., Nature Comment (2016), https://www.nature.com/news/reduction-redraction-disturb-20-c02-removal-methods-1.1938. [Jennifer Morgan, Netherlands] (Noted - however, the water footprint has already been discussed on the previous page. The assessment by Smith et al. (2016) has been included.)

Suggest changing ‘CCS is problematic’ to ‘CCS is perceived problematic by some’ or similar. [Jaarne Kemper, United Kingdom (of Great Britain and Northern Ireland)] (Accepted - note that the CCS assessment has moved to 4.3.2.)

Do Not Quote, Cite, or Distribute Page 89 of 159
The section clearly states that DAC is inefficient, energy intensive and suffers from the same barriers, deficiencies and uncertainties as any CCS-based technology - it should be made clear that it is not a viable response to climate change. Given the above, Chapter 4 authors should definitely not call for incorporation of DAC(5) into IAMs scenario (Lü Fu, Germany).

Agreed that DAC(CS) capture is more costly than capture from CO2 rich emissions streams, such as fossil-fired generating stations. But under a 1.5°C pathway, the number of emissions (in)sources shrinks rapidly, ultimately leaving DACs as the only potentially large scale option (Erik Matzke, Canada).

Again DAC is presented here as another option, as it is already an established, deployable technology with associated infrastructure. The grossly misleading interpretation of the current state of DAC(CS) is probably what is hinted at here with reference to a single paper from 1996 which has been much criticized. Furthermore, claiming that DACs has particular advantages and can capture CO2 (which is true from certain air emissions and thus also from other air emissions and thus also from other air emissions) from certain other emissions and thus also from other air emissions is stretching assumptions about its future development, efficiency and application to the extreme (see e.g. Wilco etc. (2017) https://doi.org/10.1088/1748-9225/aa85f5). Such unspecified statements in support of a largely conceptual technology which carries a range of significant downsides will encourage uneconomic policy decisions. (Jennifer Morgan, Netherlands)

A few checks of the literature suggest that the high agreement may be due to the fact most articles refer to the same primary source, in some cases via 43 articles. [Jalal Wachsmuth, Germany]

Reference to air capture should include, to be balanced, key refs to studies highlighting the technical and economic challenges (respect to BECCS when discussing about negative emissions or respect to CCS). Example of such reference is a PHAS article of House et al 2011 (http://www.pnas.org/content/108/51/20428). (Abanades Carlos, Spain)

Acknowledged that DACS would require 45 GJ/t CO2. This is about 5 times more than the energy (LHV) that is produced from the burning of carbon that would produce 1 CO2. This is thus at least 5 times more than the electrical or thermal energy that has been obtained from the burning of the carbon produced by DAC(CS) (which is probably 10 - 300 m3 per Gton C-eq. [Caserini Stefano, Italy]

It is indicated that DAC(CS) would require 45 GJ/t CO2. This is about 5 times more than the energy (LHV) that has been produced from the burning of carbon that would produce 1 CO2. This is thus at least 5 times more than the electrical or thermal energy that has been obtained from the burning of the carbon produced by DAC(CS). DAC(CS) requires about 10 times more energy than it does to obtain from carbon burning. There are surely more interesting options to be engaged with such an amount of energy. This kind of analysis shows that the different proposed techniques should (must) be assessed at the light of their efficiency in comparison with other techniques. This kind of analysis is necessary for a realistic assessment of the different pathways and would strengthen and give more interest to the document. (Jean Marie Seiler, France)

Given the huge uncertainties surrounding DAC(CS) as a concept, incorporating it more widely into models could be highly premature (Jennifer Morgan, Netherlands).

Agreed that DAC(CS) capture is more costly than capture from CO2 rich emissions streams, such as fossil-fired generating stations. But under a 1.5°C pathway, the number of emissions (in)sources shrinks rapidly, ultimately leaving DACs as the only potentially large scale option (Erik Matzke, Canada).

The unit must be incorrect. [Olivier Boucher, France]

Move "Broehm et al." into grey shaded Mendeley field with "2015" [Wilfran Moufouma Okia, France]

The major reason is that DACCS is less area intensive (compared to BECCS it does not need large areas for biomass production). [Kenneth Möllersten, Sweden]

Noted - the large potential of DACCS in comparison with other CDR options is now visualized in Figure 4.3.8. Panel A. However, costs have to be assessed as well.

It is indicated that DAC(CS) would require 45 GJ/t CO2. This is about 5 times more than the energy (LHV) that has been produced from the burning of carbon that would produce 1 CO2. This is thus at least 5 times more than the electrical or thermal energy that has been obtained from the burning of the carbon produced by DAC(CS). DAC(CS) requires about 10 times more energy than it does to obtain from carbon burning. There are surely more interesting options to be engaged with such an amount of energy. This kind of analysis shows that the different proposed techniques should (must) be assessed at the light of their efficiency in comparison with other techniques. This kind of analysis is necessary for a realistic assessment of the different pathways and would strengthen and give more interest to the document. (Jean Marie Seiler, France)

Agreed - however, (1) it is beyond the mandate of 4.3.8 to prescribe what is "viable" - we have to assess all dimensions of feasibility for a fair assessment; (2) DAC(CS) is already being incorporated into IAMs, which is what is stated here (with references) in this paragraph starting with "Current research...".

Agreed that DAC(CS) capture is more costly than capture from CO2 rich emissions streams, such as fossil-fired generating stations. But under a 1.5°C pathway, the number of emissions (in)sources shrinks rapidly, ultimately leaving DACs as the only potentially large scale option (Erik Matzke, Canada).

The unit must be incorrect. [Olivier Boucher, France]

Is this really km3 ?? This seems huge [Noé Lecocq, Belgium]

Agreed that DAC(CS) capture is more costly than capture from CO2 rich emissions streams, such as fossil-fired generating stations. But under a 1.5°C pathway, the number of emissions (in)sources shrinks rapidly, ultimately leaving DACs as the only potentially large scale option (Erik Matzke, Canada).

The unit must be incorrect. [Olivier Boucher, France]

Agreed that DAC(CS) capture is more costly than capture from CO2 rich emissions streams, such as fossil-fired generating stations. But under a 1.5°C pathway, the number of emissions (in)sources shrinks rapidly, ultimately leaving DACs as the only potentially large scale option (Erik Matzke, Canada).

The unit must be incorrect. [Olivier Boucher, France]

Agreed that DAC(CS) capture is more costly than capture from CO2 rich emissions streams, such as fossil-fired generating stations. But under a 1.5°C pathway, the number of emissions (in)sources shrinks rapidly, ultimately leaving DACs as the only potentially large scale option (Erik Matzke, Canada).

The unit must be incorrect. [Olivier Boucher, France]

Agreed - however, (1) it is beyond the mandate of 4.3.8 to prescribe what is "viable" - we have to assess all dimensions of feasibility for a fair assessment; (2) DAC(CS) is already being incorporated into IAMs, which is what is stated here (with references) in this paragraph starting with "Current research...".

Agreed that DAC(CS) capture is more costly than capture from CO2 rich emissions streams, such as fossil-fired generating stations. But under a 1.5°C pathway, the number of emissions (in)sources shrinks rapidly, ultimately leaving DACs as the only potentially large scale option (Erik Matzke, Canada).

The unit must be incorrect. [Olivier Boucher, France]

Agreed that DAC(CS) capture is more costly than capture from CO2 rich emissions streams, such as fossil-fired generating stations. But under a 1.5°C pathway, the number of emissions (in)sources shrinks rapidly, ultimately leaving DACs as the only potentially large scale option (Erik Matzke, Canada).

The unit must be incorrect. [Olivier Boucher, France]

Agreed - however, (1) it is beyond the mandate of 4.3.8 to prescribe what is "viable" - we have to assess all dimensions of feasibility for a fair assessment; (2) DAC(CS) is already being incorporated into IAMs, which is what is stated here (with references) in this paragraph starting with "Current research...".

Agreed that DAC(CS) capture is more costly than capture from CO2 rich emissions streams, such as fossil-fired generating stations. But under a 1.5°C pathway, the number of emissions (in)sources shrinks rapidly, ultimately leaving DACs as the only potentially large scale option (Erik Matzke, Canada).

The unit must be incorrect. [Olivier Boucher, France]

Agreed that DAC(CS) capture is more costly than capture from CO2 rich emissions streams, such as fossil-fired generating stations. But under a 1.5°C pathway, the number of emissions (in)sources shrinks rapidly, ultimately leaving DACs as the only potentially large scale option (Erik Matzke, Canada).

The unit must be incorrect. [Olivier Boucher, France]
Revised - REDD+ is a UNFCCC mechanism. 4.3 assesses mitigation options. Of these, reduced emissions from avoided deforestation are assessed in section 4.3.3 (along with ecosystem restoration) and all land-based options that remove carbon from the atmosphere (i.e. also afforestation) are assessed in the CDR section (4.3.1).

Accepted - definition has been added for afforestation and reforestation.

Revised - afforestation is reviewed in the paragraph subject to the "interests to BECCS. All CDR options have been assessed with respect to cost and criteria and afforestation performs better on the co-benefit and on the permanence according to the literature. Note that in this section the mandate is to look at everything that withdraws CO2 from the atmosphere. Avoided deforestation is part of the AFOLU section, 4.3.3.

Accepted - large-scale afforestation with monoculture plantations is detrimental to biodiversity, ecosystem integrity and resilience, and land- and land-use rights of local and indigenous communities, and is excessively land and water intensive. Monoculture plantations are moreover easily inflammable. In general, biosequestration is unfulfilled to ensure the level of permanence with which emissions need to be reduced. Chapter 4 authors should focus on means to stop deforestation and allow for reforestation in susceptible and careful ways. In general, careful ecosystem restoration should be prioritised, rather than land-based geoengineering technoges. [Lil Forf, Germany]

Accepted - In this sentence the potential for mitigation in the forest sector is estimated to be 6.5 Gt CO2 eq and up to 13.8 Gt CO2 equivalent at USD 50 per ton of CO2. The reason for this different cost estimates is not given. [Harold Leffertstra, Norway]

Accepted - The entire section on the potential for mitigation in the forest sector is for a estimate to be 6.5 Gt CO2 eq and up to 13.8 Gt CO2 equivalent at USD 50 per ton of CO2. Taken into account - the full assessment of potentials and costs was only finished after the FOD and the text (incl. numbers) has now been amended. Note that the text has changed substantially.

Accepted - We note the progression of sinks is important and they are taken into account in the carbon budgets. However, additional removal of CO2 is needed to reach 1.5 °C, which is how Section 4.3 assessed in 4.3.5 along with potential co-benefits. Forests and avoided deforestation are very important in climate change mitigation as well and are assessed in detail in the AFOLU section, 4.3.3.

Accepted - This is not correct. It states that there are significant overlaps between

Accepted - The authors seem to know the reasons for current deforestation dynamics and their impact to be problematic. [Zohe Shevock, United Kingdom (of Great Britain and Northern Ireland)]

Accepted - Partially taken into account - impact on local livelihoods is considered as a side effect. The task of the section is, however, to assess AR as a CDR option.

Accepted - "Move "Houghton et al. into grey shaded Mondyfield with "2015" (Wirth Mondusco Ola, France)

Editorial - Moving "Houghton et al. into grey shaded Mondyfield with "2015" (Wirth Mondusco Ola, France) to the current location. [Kamal Saeed, United States of America]

Accepted - Noted - however, this information is now presented in a box on land-based CDR in chapter 3 (Box 3.1.1). Please refer to 4.3.3 for the assessment of avoided deforestation. Due to space constraints, we cannot offer a full regional assessment.

Accepted - Noted - we agree that the preservation of sinks is important and they are taken into account in the carbon budgets. However, additional removal of CO2 is needed to reach 1.5 °C, which is how Section 4.3 assessed in 4.3.5 along with potential co-benefits. Forests and avoided deforestation are very important in climate change mitigation as well and are assessed in detail in the AFOLU section, 4.3.3.

Noted - We agree that the preservation of sinks is important and they are taken into account in the carbon budgets. However, additional removal of CO2 is needed to reach 1.5 °C, which is how Section 4.3 assessed in 4.3.5 along with potential co-benefits. Forests and avoided deforestation are very important in climate change mitigation as well and are assessed in detail in the AFOLU section, 4.3.3.

Noted - We agree that the preservation of sinks is important and they are taken into account in the carbon budgets. However, additional removal of CO2 is needed to reach 1.5 °C, which is how Section 4.3 assessed in 4.3.5 along with potential co-benefits. Forests and avoided deforestation are very important in climate change mitigation as well and are assessed in detail in the AFOLU section, 4.3.3.

Noted - The mandate is to look at everything that withdraws CO2 from the atmosphere. Avoided deforestation is part of the AFOLU section, 4.3.3.

Revised - REDD+ is a UNFCCC mechanism. 4.3 assesses mitigation options. Of these, reduced emissions from avoided deforestation are assessed in section 4.3.3 (along with ecosystem restoration) and all land-based options that remove carbon from the atmosphere (i.e. also afforestation) are assessed in the CDR section (4.3.1).

Accepted - definition has been added for afforestation and reforestation.

Revised - afforestation is reviewed in the paragraph subject to the "interests to BECCS. All CDR options have been assessed with respect to cost and criteria and afforestation performs better on the co-benefit and on the permanence according to the literature. Note that in this section the mandate is to look at everything that withdraws CO2 from the atmosphere. Avoided deforestation is part of the AFOLU section, 4.3.3.

Accepted - large-scale afforestation with monoculture plantations is detrimental to biodiversity, ecosystem integrity and resilience, and land- and land-use rights of local and indigenous communities, and is excessively land and water intensive. Monoculture plantations are moreover easily inflammable. In general, biosequestration is unfulfilled to ensure the level of permanence with which emissions need to be reduced. Chapter 4 authors should focus on means to stop deforestation and allow for reforestation in susceptible and careful ways. In general, careful ecosystem restoration should be prioritised, rather than land-based geoengineering technologies. [Lil Forf, Germany]

Accepted - In this sentence the potential for mitigation in the forest sector is estimated to be 6.5 Gt CO2 eq and up to 13.8 Gt CO2 equivalent at USD 50 per ton of CO2. The reason for this different cost estimates is not given. [Harold Leffertstra, Norway]

Accepted - The entire section on the potential for mitigation in the forest sector is for a estimate to be 6.5 Gt CO2 eq and up to 13.8 Gt CO2 equivalent at USD 50 per ton of CO2. Taken into account - the full assessment of potentials and costs was only finished after the FOD and the text (incl. numbers) has now been amended. Note that the text has changed substantially.

Accepted - We agree that the preservation of sinks is important and they are taken into account in the carbon budgets. However, additional removal of CO2 is needed to reach 1.5 °C, which is how Section 4.3 assessed in 4.3.5 along with potential co-benefits. Forests and avoided deforestation are very important in climate change mitigation as well and are assessed in detail in the AFOLU section, 4.3.3.

Accepted - "Move "Houghton et al. into grey shaded Mondyfield with "2015" (Wirth Mondusco Ola, France)

Editorial - Moving "Houghton et al. into grey shaded Mondyfield with "2015" (Wirth Mondusco Ola, France) to the current location. [Kamal Saeed, United States of America]

Accepted - Noted - however, this information is now presented in a box on land-based CDR in chapter 3 (Box 3.1.1). Please refer to 4.3.3 for the assessment of avoided deforestation. Due to space constraints, we cannot offer a full regional assessment.

Accepted - Noted - we agree that the preservation of sinks is important and they are taken into account in the carbon budgets. However, additional removal of CO2 is needed to reach 1.5 °C, which is how Section 4.3 assessed in 4.3.5 along with potential co-benefits. Forests and avoided deforestation are very important in climate change mitigation as well and are assessed in detail in the AFOLU section, 4.3.3.

Noted - We agree that the preservation of sinks is important and they are taken into account in the carbon budgets. However, additional removal of CO2 is needed to reach 1.5 °C, which is how Section 4.3 assessed in 4.3.5 along with potential co-benefits. Forests and avoided deforestation are very important in climate change mitigation as well and are assessed in detail in the AFOLU section, 4.3.3.

Noted - The mandate is to look at everything that withdraws CO2 from the atmosphere. Avoided deforestation is part of the AFOLU section, 4.3.3.

Revised - REDD+ is a UNFCCC mechanism. 4.3 assesses mitigation options. Of these, reduced emissions from avoided deforestation are assessed in section 4.3.3 (along with ecosystem restoration) and all land-based options that remove carbon from the atmosphere (i.e. also afforestation) are assessed in the CDR section (4.3.1).

Accepted - definition has been added for afforestation and reforestation.

Revised - afforestation is reviewed in the paragraph subject to the "interests to BECCS. All CDR options have been assessed with respect to cost and criteria and afforestation performs better on the co-benefit and on the permanence according to the literature. Note that in this section the mandate is to look at everything that withdraws CO2 from the atmosphere. Avoided deforestation is part of the AFOLU section, 4.3.3.

Accepted - large-scale afforestation with monoculture plantations is detrimental to biodiversity, ecosystem integrity and resilience, and land- and land-use rights of local and indigenous communities, and is excessively land and water intensive. Monoculture plantations are moreover easily inflammable. In general, biosequestration is unfulfilled to ensure the level of permanence with which emissions need to be reduced. Chapter 4 authors should focus on means to stop deforestation and allow for reforestation in susceptible and careful ways. In general, careful ecosystem restoration should be prioritised, rather than land-based geoengineering technologies. [Lil Forf, Germany]

Accepted - In this sentence the potential for mitigation in the forest sector is estimated to be 6.5 Gt CO2 eq and up to 13.8 Gt CO2 equivalent at USD 50 per ton of CO2. The reason for this different cost estimates is not given. [Harold Leffertstra, Norway]

Accepted - The entire section on the potential for mitigation in the forest sector is for a estimate to be 6.5 Gt CO2 eq and up to 13.8 Gt CO2 equivalent at USD 50 per ton of CO2. Taken into account - the full assessment of potentials and costs was only finished after the FOD and the text (incl. numbers) has now been amended. Note that the text has changed substantially.

Accepted - We agree that the preservation of sinks is important and they are taken into account in the carbon budgets. However, additional removal of CO2 is needed to reach 1.5 °C, which is how Section 4.3 assessed in 4.3.5 along with potential co-benefits. Forests and avoided deforestation are very important in climate change mitigation as well and are assessed in detail in the AFOLU section, 4.3.3.
This paragraph makes several correct points yet it misses some aspects due to the lack of clarity. It is stating that emissions reductions are a whole without looking at the different options. There is a good opportunity to expand the need for reducing dynamic and non-dynamic carbon emissions. BECCS also CCS should target non-dynamic carbon, e.g., from oil. Neither be should be aimed at dealing with emissions from dynamic systems such as themselves and AFOLU-related emissions. Hence the need to expand complementarily (e.g., biochar-amended soils, United States of America). Disagreed. The intention is not to imply that different mitigation options are mutually exclusive. A sentence has been added to clarify this at the end of the paragraph. Unfortunately, space constraints keep us from going more deeply into the details of what is called here dynamic vs. non-dynamic emissions.

In "low agreement." This statement doesn't do justice to the literature. Generally, reforestation and other ecosystems reforestation is beneficial for biodiversity. For reforestation, soil specific, depending on the location, or reforestation of grassy areas is often positive. Nevertheless, the need for reforestation is still a matter of debate. The idea of reforestation is often questioned. See also comment 11161. The intention is not to imply that different mitigation options are mutually exclusive. A sentence has been added to clarify this at the end of the paragraph. Unfortunately, space constraints keep us from going more deeply into the details of what is called here dynamic vs. non-dynamic emissions.

The sentence states that climate change mitigation and reforestation not necessarily have a positive effect on ecosystems and biodiversity. For reforestation and afforestation that seems to be reasonable since these options are often carried out as monoculture plantations. Noted — the assessment has been finalized after the FOD and side effects (tradeoffs and co-benefits) are now assessed more systematically. Also see Fig. 4.3.8. Note however nowhere it is said that BECCS is to be preferred over afforestation. We are assessing all options along the same dimensions without presupposing anything.

Beaches "Roos et al." may be added into grey shaded Mendeley field with "2017". Wilfran Moufouma Okia, France

There are serious doubts not only about the sustainability of production on large scale, but also about the effectiveness of biochar as a means to sequester carbon in soils, and other impacts on soils and crop growth (See for example: Viger, M. Harrold, F.M. and Taylor, G. 2015. More plant growth but less plant defence? First global gene expression data for plants grown in soil amended with biochar. Crop and Pasture Science, 66: 685-687.)

Agreed — though no literature could be found for the other land-based options, a remark has been added here in this respect.

We also put out that biochar production, though it is referred to as a "negative emission" technology, does not usually involve production of any usable energy from the process itself, and there is no commercial use of the burn off gases from the combustion. This is true. The combustion is not complete, the energy generated is not as great as that produced by

For more details on how there is probably more confidence in biodiversity and ecosystem services case. https://nlr.forestry.gov.au/Features/Deforestation/1. Maybe the distinction between avoided deforestation and afforestation, and give more details to illustrate why there is low agreement on biodiversity and ecosystem services (which is somewhat counter-intuitive). Noted — the section now deals only with afforestation and 4.3.3 assesses avoided deforestation now.

The sentence states that climate change mitigation and reforestation not necessarily have a positive effect on ecosystems and biodiversity. For reforestation and afforestation that seems to be reasonable since these options are often carried out as monoculture plantations. Noted — the assessment has been finalized after the FOD and side effects (tradeoffs and co-benefits) are now assessed more systematically. Also see Fig. 4.3.8. Note however nowhere it is said that BECCS is to be preferred over afforestation. We are assessing all options along the same dimensions without presupposing anything.

There are serious doubts not only about the sustainability of production on large scale, but also about the effectiveness of biochar as a means to sequester carbon in soils, and other impacts on soils and crop growth (See for example: Viger, M. Harrold, F.M. and Taylor, G. 2015. More plant growth but less plant defence? First global gene expression data for plants grown in soil amended with biochar. Crop and Pasture Science, 66: 685-687.)

Agreed — though no literature could be found for the other land-based options, a remark has been added here in this respect.

We also put out that biochar production, though it is referred to as a "negative emission" technology, does not usually involve production of any usable energy from the process itself, and there is no commercial use of the burn off gases from the combustion. This is true. The combustion is not complete, the energy generated is not as great as that produced by

For more details on how there is probably more confidence in biodiversity and ecosystem services case. https://nlr.forestry.gov.au/Features/Deforestation/1. Maybe the distinction between avoided deforestation and afforestation, and give more details to illustrate why there is low agreement on biodiversity and ecosystem services (which is somewhat counter-intuitive). Noted — the section now deals only with afforestation and 4.3.3 assesses avoided deforestation now.

The sentence states that climate change mitigation and reforestation not necessarily have a positive effect on ecosystems and biodiversity. For reforestation and afforestation that seems to be reasonable since these options are often carried out as monoculture plantations. Noted — the assessment has been finalized after the FOD and side effects (tradeoffs and co-benefits) are now assessed more systematically. Also see Fig. 4.3.8. Note however nowhere it is said that BECCS is to be preferred over afforestation. We are assessing all options along the same dimensions without presupposing anything.

There are serious doubts not only about the sustainability of production on large scale, but also about the effectiveness of biochar as a means to sequester carbon in soils, and other impacts on soils and crop growth (See for example: Viger, M. Harrold, F.M. and Taylor, G. 2015. More plant growth but less plant defence? First global gene expression data for plants grown in soil amended with biochar. Crop and Pasture Science, 66: 685-687.)

Agreed — though no literature could be found for the other land-based options, a remark has been added here in this respect.
These technologies would require similar processes of public engagement and contextual testing. The report should warn strongly that authors are sharing results of CO2 removal - not necessarily recommending them, due to ethical considerations. [Suresh Potarre, Gujarat, India]

N60 - all options are assessed along the same dimensions and no prescriptions have been made. As a matter of fact, the literature on public acceptance of BECCS is much larger than for CO2 removal.

- The meaning of the sentence is less clear. When biochar is used for sequestering carbon it will extract CO2 from the atmosphere. When used to replace fossil fuels it will not extract CO2 from the atmosphere, but prevent that fossil carbon is turned into CO2 and emitted into the atmosphere. This difference is stated in the text 25-26 [Hansel, Lofken, Norway]

- Negative impacts mean that there will be more or less acidification? Please clarify that according to Taylor enhanced weathering scenarios over less alkaline systems, instead of reducing acidification, will lead to increased acidification [Jennifer Morgan, Netherlands]

- While the analysis provided by Renforth and Henderson (2017) does indeed provide some estimates for sequestration potential for ocean alkalination and hydrogen production, this is not an option and thus should not be assessed in the same way as ocean alkalination.

- The benefit of using biochar in agriculture can be assessed with the help of various models, but the energy generated is not as great as that produced by total combustion (as in bioenergy), but the process nevertheless generates some energy while making the biochar.

- Taken into account - a systematic assessment of all CDR options including ocean alkalination has been finished after the FOD and included in the SOD.

- When biochar is used for sequestering carbon it will extract CO2 from the atmosphere. When used to replace fossil fuels it will not extract CO2 from the atmosphere, but prevent that fossil carbon is turned into CO2 and emitted into the atmosphere. This difference is stated in the text 25-26 [Hansel, Lofken, Norway]

- The literature on public acceptance of BECCS is much larger than for CO2 removal.

- Negative impacts mean that there will be more or less acidification? Please clarify that according to Taylor enhanced weathering scenarios over less alkaline systems, instead of reducing acidification, will lead to increased acidification [Jennifer Morgan, Netherlands]

- While the analysis provided by Renforth and Henderson (2017) does indeed provide some estimates for sequestration potential for ocean alkalination and hydrogen production, this is not an option and thus should not be assessed in the same way as ocean alkalination.

- The benefit of using biochar in agriculture can be assessed with the help of various models, but the energy generated is not as great as that produced by total combustion (as in bioenergy), but the process nevertheless generates some energy while making the biochar.

- Negative impacts mean that there will be more or less acidification? Please clarify that according to Taylor enhanced weathering scenarios over less alkaline systems, instead of reducing acidification, will lead to increased acidification [Jennifer Morgan, Netherlands]

- While the analysis provided by Renforth and Henderson (2017) does indeed provide some estimates for sequestration potential for ocean alkalination and hydrogen production, this is not an option and thus should not be assessed in the same way as ocean alkalination.

- Taken into account - a systematic assessment of all CDR options including ocean alkalination and hydrogen production has been finished after the FOD and included in the SOD. See also 10731.
### Comment Response

<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>14133</td>
<td>37</td>
<td>9</td>
<td>37</td>
<td>10</td>
<td>The double negative is misleading, suggest clarify by: &quot;positive impacts namely reduction of ocean acidification&quot; or same such wording [Ehre Polszczanka, Germany]</td>
</tr>
<tr>
<td>14134</td>
<td>37</td>
<td>9</td>
<td>37</td>
<td>10</td>
<td>Unexpected ecosystem impacts are not discussed [Ehre Polszczanka, Germany]</td>
</tr>
<tr>
<td>20646</td>
<td>9</td>
<td>37</td>
<td>10</td>
<td>10</td>
<td>Consider to change the sentence &quot;... with significant decreased ocean acidification, [Hans Lefterieft, Norway]</td>
</tr>
<tr>
<td>14275</td>
<td>37</td>
<td>9</td>
<td>37</td>
<td>9</td>
<td>Negative impacts on ocean acidification&quot; the phrase is unclear. 1. Is this preventing ocean acidification (I doubt it). 2. I'm having a negative impact on the ocean's pH? I think I see what's meant, but a mirror would clarify this bit. [Jason Done, Canada]</td>
</tr>
<tr>
<td>13072</td>
<td>37</td>
<td>12</td>
<td>37</td>
<td>13</td>
<td>free mussel feeding does mean &quot;prohibitive&quot;</td>
</tr>
<tr>
<td>7965</td>
<td>37</td>
<td>12</td>
<td>37</td>
<td>13</td>
<td>Not only costs but also environmental requirements and their related emissions. Is not negative as these pathways once you take those into account, e.g. the grinding of large amounts of rock material? [Elin Kemper, United Kingdom; of Great Britain and Northern Ireland]</td>
</tr>
<tr>
<td>20834</td>
<td>37</td>
<td>13</td>
<td>37</td>
<td>15</td>
<td>As well as economic costs and the effect of dust, the large upwelling of quenning, mining and transport activity needed for large scale enhanced</td>
</tr>
<tr>
<td>4987</td>
<td>37</td>
<td>17</td>
<td></td>
<td></td>
<td>Change &quot;Gt CO2 per year&quot; by &quot;Gt CO2 yr-1&quot; [Radim Tolasz, Czech Republic]</td>
</tr>
</tbody>
</table>
It is not that the low confidence in the amount of carbon that could be stored through ocean fertilisation arises because only small-scale field experiments and theoretical modelling have been conducted so far. The low confidence has come as a result of the field testing that has been done, i.e. the participants are aware of the complexity and variability of the system under study, and not the lack of such study (see e.g. Boyd et al. 2007 [DOI 10.1126/science.1131669], Williamson et al. 2012 https://doi.org/10.1016/j.psep.2012.10.007]). This is clear from many authoritative published assessments on ocean fertilisation [Jenifer Morgan, Netherlands].

Accepted - ocean fertilisation example has been added to new governance paragraph in this section.

There is broad agreement that OF as a negative emissions technique is likely to play a modest role in netting out future climate forcing – what is this based on? Only one paper (from 2012) is cited. Ocean fertilisation is a highly controversial option, and this section should put more emphasis on the associated risks. Its classification as a CO2 technique could be questioned given these risks and the uncertainty over whether carbon is actually removed.

It must be discussed here that OF is problematic under the United Nations Convention on Biodiversity (CBD) and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention) [Michael Schaefer, Netherlands].

Accepted - This is not about biodiversity, but the reference is: Phillip Williamson, Douglas W. A. Wallis, C.R. Hill, L. Ph. Wy, Boyd, Yves Cubas, Peter Cost, Ken Derriman, Ulf Riebesell, Shigenobu Takeda, Chris Vivian, Ocean fertilisation for geoengineering: A review of effectiveness, environmental impacts and emerging governance, in Process Safety and Environmental Protection. Volume 90, issue 6, 2012, Pages 475-486, ISSN 0957-5820. It has been incorporated in the reference list, thanks for spotting.

It is indicated that "carbon dioxide has a large potential as synthetic feedstock for chemical materials". CO2 has a very low formation enthalpy (-393 kJ/mole) in comparison with chemical compounds of interest (plastics, CH4, CO2 fuels, etc... formation enthalpy ~ -50 to -150 kJ/mole per atom carbon. Polyethylene formation has a formation enthalpy of ~ -140 kJ/mole per atom of carbon). This means that the formation enthalpy difference must be compensated by a very important energy input to produce synthetic feedstocks from CO2. When process losses are accounted for, the necessary energy input is generally much greater (factor 4 to 10) than the energy that has been gained from the carbon formation. This is generally valid for all CO2 chemical conversion processes and hampers seriously the interest of all these chemical processes. As in the case of DACS, this energy input compensated by a very important energy input to produce synthetic feedstocks from CO2. When process losses are accounted for...

It is better to delete the part of the sentence: "who..."

This is an accurate reference to a statement made in that paper, but somewhat outdated as international governance of field-based research on ocean fertilisation is a reality, as noted above (and as reflected by Williamson & Bodie 2010, among others) [Jenifer Morgan, Netherlands].

Accepted - ocean fertilisation example has been added to new governance paragraph in this section.

DO NOT QUOTE, CITE, OR DISTRIBUTE: Page 95 of 159

IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4
It has to be said here that using CO2 as chemical building block requires a large amount of energy input to reduce the carbon (carbonates are the ONLY exception). Such energy must come for renewables and is huge (because of the second law of thermodynamics), no catalysis can do anything to avoid such huge penalty. If the renewable energy needed to reduce CO2 were used to substitute carbon-based electricity the CO2 emission mitigation effect would be much stronger. [Marco Mazzotti, Switzerland]

Comment: This is one of the main reasons that leads to a rather pessimistic outlook for the role of CO2 in mitigation, see e.g. MacDowell et al. (2017) referenced here. Noted - comment transferred to 4.3.2, where CO2 and CCS are now assessed.

Enhanced oil recovery has been promoting oil extraction, thereby increasing the amount of oil that we can afford to get out of the ground. Something that presumably read "of 'blue carbon', which...". [Amory Lovins, United States of America] Noted - however, this part of the text is gone due to major shortening of the CDR section.

It is true that all the DAC technologies are not currently economically or energetically suitable for the large scale air capture; the point is whether or not in the future the costs could be reduced, through R&D and learning by doing. Something should be added on this point [Garién Stefaños, Italy]

Response: Accepted

Reduced CCS: We focus only on carbon removal here and assume that CCUS does not necessarily have to lead to negative emissions, indeed. Unfortunately, we cannot include non-peer-reviewed literature, but see our sen.Aassen et al. to make this point.

It has to be said here that using CO2 as chemical building block requires a large amount of energy input to reduce the carbon (carbonates are the ONLY exception). Such energy must come for renewables and is huge (because of the second law of thermodynamics), no catalysis can do anything to avoid such huge penalty. If the renewable energy needed to reduce CO2 were used to substitute carbon-based electricity the CO2 emission mitigation effect would be much stronger. [Marco Mazzotti, Switzerland]

Comment: This is one of the main reasons that leads to a rather pessimistic outlook for the role of CO2 in mitigation, see e.g. MacDowell et al. (2017) referenced here. Noted - comment transferred to 4.3.2, where CO2 and CCS are now assessed.

Enhanced oil recovery has been promoting oil extraction, thereby increasing the amount of oil that we can afford to get out of the ground. Something that presumably read "of 'blue carbon', which...". [Amory Lovins, United States of America] Noted - however, this part of the text is gone due to major shortening of the CDR section.

It is true that all the DAC technologies are not currently economically or energetically suitable for the large scale air capture; the point is whether or not in the future the costs could be reduced, through R&D and learning by doing. Something should be added on this point [Garién Stefaños, Italy]

Response: Accepted

Reduced CCS: We focus only on carbon removal here and assume that CCUS does not necessarily have to lead to negative emissions, indeed. Unfortunately, we cannot include non-peer-reviewed literature, but see our sen.Aassen et al. to make this point.

Response: Accepted
4308
39

As a non-expert, I find section 4.3.7 very interesting and relevant. The length dedicated to this subsection highlights a big problem in the structure and coverage of key topics in the whole chapter. Example: the section on Solar Radiation Management subsection covers almost 3 pages and 3 subsections, while MAJOR RENEWABLE TECHNOLOGIES (wind, solar PV, concentrated solar power, geothermal, tidal etc) are treated in half a page or less, and encompassing big topics like Energy Storage (from thermal / electric, from short term to seasonal, from small devices to network balancing large scale energy storage systems) get very little attention. It is a report on how to get to 1.5°C the same looks odd, and it is highly misleading: we may be pulling the short light on the wrong issues/topics [[Abendes Carlos, Spain]].

Taken into account, text shortened in order to make chapter more balanced

6205
39
39

The discussion of SRM ought to be made more specifically focused on the 1.5°C temperature question. At the moment it repeats the various discussions in different parts of AR5, with a lot of updating for more recent literature and debates. It seems to me there is an opportunity here to be quite specific about which SRM/CDR technologies might be brought into play within the timeframes to achieve 1.5°C, and with what sort of risks associated with them. (Matthew Peterson, United Kingdom; [of Great Britain and Northern Ireland]).

Taken into account, SRM implications in context of 1.5 covered in the SRM Box, here we have moved text to clarify scoping of implementation related to 1.5

18446
39
39
5

Move "Johannessen and Macdonald" into grey shaded Mendeley field with "2016" [Wilfran Moufouma Okia, France] Accepted

18447
39
39
5

Move "Johannessen and Macdonald" into grey shaded Mendeley field with "2016" [Wilfran Moufouma Okia, France] Accepted

18448
39
39
5

Move "Johannessen and Macdonald" into grey shaded Mendeley field with "2016" [Wilfran Moufouma Okia, France] Accepted

17391
39

Virtually no assessment work has been done on the impact on Blue Carbon release from the practice of dredging for shipping channels, adaptation see defences and port development. The estimates of material dredged are between 250-400 m3 per tonne per year worldwide and could become higher once increased sea defence work and restoration of shipping channels is required from larger/more violent weather conditions. Much of the near shore and marine defences is potentially high in degraded organic matter. [Gavin Allwright, United Kingdom; [of Great Britain and Northern Ireland]]

Taken into account - there is a number of CDR options, for which the evidence base is low, as is the case for the side effects of blue carbon. It has therefore been moved to a section entitled "other and emerging CDR options", just explaining the concepts and highlighting the need for further research

18449
39
39
8

Move "Johannes" into grey shaded Mendeley field with "2016" [Wilfran Moufouma Okia, France] Accepted

14439
39
39
12
12

A few comments on the current text. It is probably too much of an overall review of the current work. [Jason Doney, Canada] Accepted

14540
39
39
14
14

Move "Robock et al." into grey shaded Mendeley field with "2002" [Wilfran Moufouma Okia, France] Accepted

1129
39
39
15
15

 Personally, I find the attention to SRM (including the blue box at the end of page 12 out of 100 pages) way too much. Emissions reductions in the energy sector are by far the most important things we need to do. [Helene Muri, Norway] Accepted

18451
39
39
15
15

Move "The Royal Society" into grey shaded Mendeley field with "2009" [Wilfran Moufouma Okia, France] Accepted

4390
39
39
15
34

I conclude in this section some of the ideas discussed in the work developed by Parson [2017] (PNAS): "Climate policymakers and assessors must get serious about climate engineering" [Gisela de Oliveira, Brazil]

Taken into account - Suggestions of this paper we have already took into account

12288
39
39
15
41
49

I have a brief discussion about what can be inferred from the Paris Agreement would be needed here. I also suggest that this includes a brief discussion of whether SRM can be used in the definition of "balance" (see discussion in Fuglestvedt et al., 2017) (see references in chapter 1) [Jen Fuglestvedt, Norway] Accepted

13406
39

It is not clear why the focus is on SAI and CMB in Section 4.3.7, while on SGI and SAI in Section 4.3.7.1. I would suggest to assess SGI, SAI and CMB in both sections. [Helene Muri, Norway] Accepted

20142
39
49

McLaren [2018] [Lili Fuhr, Germany] Accepted

20144
39
49

Chapter 4 authors should be particularly aware of their moral and scientific responsibility and strive appropriate conclusions from the various risks associated with SRM already referenced in the chapter that may have any serious concerns of SRM technologies undesirable and untenable. [Lili Fuhr, Germany] Accepted

20151
39
49

Stuart et al. [2017] Public perception of climate engineering and carbon capture and storage in Germany: survey evidence. In: Climate Policy, http://dx.doi.org/10.1080/14693062.2017.1304885 - show how SRM is "widely rejected" among the German public. [Lili Fuhr, Germany] Accepted

1213
39
49

Touraine et al. [2014] "Climate engineering is mentioned in one place in the context of "Declaration of Lam 3." [Patrice Tschersich, Australia] Accepted

20157
39
49


21181
39
49


21162
39
49

Note that the convention on biological Diversity has adopted decisions on geoengineering including SRM see decision X/20 (https://www.cbd.int/decisions/cop/default.shtml?id=13181) and Decision X/10 and decision X/20 (both) which invites parties to: "Embrace, … in the absence of scientific basis, global, transparent and effective control and regulatory mechanisms for geo-engineering, and in accordance with the precautionary approach and Article 14 of the Convention, that no climate-related geo-engineering activities that may affect biodiversity take place, unless there is an adequate scientific basis on which to justify such activities and appropriate consideration of the associated risks for the environment and biodiversity and associated social, economic and cultural impacts, with the exception of small scale scientific research studies that would be conducted in a controlled setting in accordance with Article 3 of the Convention, and only if they are justified by the need to gather specific scientific data and are subject to a thorough prior assessment of the potential impacts on the environment" [David Cooper, Canada] Accepted

Do Not Quote, Cite, or Distribute Page 97 of 159
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>20159</td>
<td>39</td>
<td>15</td>
<td>41</td>
<td>49</td>
<td>Taken into account: Some of them addressed in the SRM Box, others are not discussed in peer-reviewed literature.</td>
<td></td>
</tr>
<tr>
<td>10220</td>
<td>39</td>
<td>15</td>
<td>41</td>
<td>59</td>
<td>Taken into account.</td>
<td></td>
</tr>
<tr>
<td>6187</td>
<td>39</td>
<td>20</td>
<td>39</td>
<td>20</td>
<td>Accepted, reference corrected.</td>
<td></td>
</tr>
<tr>
<td>16419</td>
<td>39</td>
<td>20</td>
<td>39</td>
<td>21</td>
<td>Taken into account, clarifications about different implementation schemes added to the section on assessment of risk.</td>
<td></td>
</tr>
<tr>
<td>6188</td>
<td>39</td>
<td>21</td>
<td>39</td>
<td>21</td>
<td>Accepted, reference added.</td>
<td></td>
</tr>
<tr>
<td>16420</td>
<td>39</td>
<td>21</td>
<td>39</td>
<td>21</td>
<td>Taken into account, text changed.</td>
<td></td>
</tr>
<tr>
<td>1518</td>
<td>39</td>
<td>23</td>
<td>39</td>
<td>23</td>
<td>Accepted.</td>
<td></td>
</tr>
<tr>
<td>6770</td>
<td>39</td>
<td>25</td>
<td>28</td>
<td>28</td>
<td>Taken into account. Section 3.7.5, moved to SRM Box, where we discuss all measures. Section 4.3.9 significantly in order to discuss SRM in terms of 1.5°C and in context of &quot;peak-shaving potential&quot; is confused.</td>
<td></td>
</tr>
</tbody>
</table>

This conceptual distinction needs to be made earlier. [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]

Accepted. Moved to the beginning of this section.

SRM is neither adaptation nor mitigation. Why? It should be explained. [Marco Mazzotti, Switzerland]

Noted. SRM do not fit the adaptation and mitigation description in the glossary.

Overall comment to integrate a rights-based approach and to mainstream gender considerations. Also to capture the co-benefits of climate action in terms of benefits to rights e.g. to health, right to shelter, rights to decent work. [Fana Shire, Ireland]

Taken into account. Clarifications about different implementation schemes added to this section.

Comment Response

Taken into account. This section reassesses the feasibility… focusing on Stratospheric Aerosol Injection (SAI) unless otherwise indicated, as most available literature is about SAI.*

15591 28 28 29

The statement that SAI and MCB would be “effective” is not proven anywhere, there is no basis. Delete that sentence. [Elena Dahi, Philippines]

Taken into account. It was rewritten. This section reassesses the feasibility… focusing on Stratospheric Aerosol Injection (SAI) unless otherwise indicated, as most available literature is about SAI.*

15443 28 28 29

The statement that SAI and MCB would be “effective” is not proven anywhere, there is no basis. Delete that sentence. [Elena Dahi, Philippines]

Taken into account. It was rewritten. This section reassesses the feasibility… focusing on Stratospheric Aerosol Injection (SAI) unless otherwise indicated, as most available literature is about SAI.*

13407 29


Taken into account. It was rewritten. This section reassesses the feasibility… focusing on Stratospheric Aerosol Injection (SAI) unless otherwise indicated, as most available literature is about SAI.*

19703 30 39 33

Overall comment to integrate a rights-based approach and to mainstream gender considerations. Also to capture the co-benefits of climate action in terms of benefits to rights e.g. to health, right to shelter, rights to decent work. [Fana Shire, Ireland]

Noted. According to the glossary: mitigation is “a human intervention to reduce the sources or enhance the sinks of greenhouse gases”. CDR enhance the sinks. This paragraph was moved to the beginning of this section.

11002 31 39 33

The conceptual distinction needs to be made earlier. [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]

Accepted. Moved to the beginning of this section.

11039 33 39 34

Simply assuming CDR as a form of mitigation goes against standard definitions of geoengineering. While there are many good reasons not to put CDR under this umbrella term any longer (e.g., Haywood 2013: Situating and Abolishing Geoengineering: A Typology of Five Runways to Fundamental Climate Change), such a move deters a thorough exploration (Shier, Gaden, Germany).

Taken into account. This paragraph extended with new literature and rewritten.

10632 34

we consider CDR as mitigation. This statement should be carefully reconsidered, and better justified. It has far-reaching implications for how CDR will be thought of if the IPCC team really agrees on this statement, then it should be explained, analysed, justified, and placed prominently in the report. Currently it is “hidden” in the section on SMI, but could easily be cited and re-used. No mention of this standpoint is made in the section on CDR (nor elsewhere, as far as I could find, though it might have overried itself in the earlier chapters). In fact, in Chapter 1, it is stated (p. 33, 1-15-16): “Extreme measures could be undertaken to avoid climate change. These include carbon dioxide removal (CDR), … which does not make it sound like CDR is viewed as mitigation by these chapter authors. Given the substantial difference between installing solar and wind power for primary energy use (mitigation) versus compensating fossil fuel CO2 emissions by using solar and wind power to drive direct air capture devices or using other approaches to remove post-facts remove CO2 from the air (CDR), I and presumably most of the community working on this - would argue that CDR and mitigation should not be considered as the same. [Mark Lawrence, Germany]

Noted. According to the glossary: mitigation is “a human intervention to reduce the sources or enhance the sinks of greenhouse gases”. CDR enhance the sinks. This paragraph was moved to the beginning of this section.

16423 34 34 34

Another potential type of application of SRM approaches is to seek to reduce the intensity of particular extreme events, such as the amplification of Arctic warming or the very warm ocean waters that are increasing the likelihood of extreme intensification of tropical cyclones in the Atlantic basin and in the western Pacific upwind of the Philippines, etc. Such potential uses have been raised by a number of researchers, including myself (see, for example, MacCracken, M.C., 2016: The rationale for accelerating regionally focused climate intervention research, Earth’s Future 4, 649-657, doi:10.1002/2016EF000450) and in papers by Stephen Salter, and in that their intended influence is to reduce specific impacts, such implementations (mitigation) versus compensating fossil fuel CO2 emissions by using solar and wind power to drive direct air capture devices or using other approaches to remove post-facts remove CO2 from the air (CDR), I and probably most of the community working on this – would argue that CDR and mitigation should not be considered as the same. [Mark Lawrence, Germany]

Noted. We accept the point but we have to be selective as to what literature to include to stay within the agreed page limit of the section.

1604 34 34 34

we consider CDR as mitigation. This is different from the previous IPCC-geoengineering review and AR5. You should be consistent with past practice. [Alan Robock, United States of America]

Noted. According to the glossary: mitigation is “a human intervention to reduce the sources or enhance the sinks of greenhouse gases”. CDR enhance the sinks. This paragraph was moved to the beginning of this section.

19327 34 34 34

SRM is neither adaptation nor mitigation. Why? It should be explained. [Marco Mazzotti, Switzerland]

Noted. SRM do not fit the adaptation and mitigation description in the glossary.

11007 39 40 9

12 The Draft’s sole paragraph outlining different governance models only cites one piece, Brandt 2017 (Reviewer of International Organizations), which is a game theory piece arguing for attention to security concerns with a fairly limited discussion of this governance options more broadly. Although an important contribution to the literature, providing this piece in your discussion of SRM governance design is insufficent. One piece currently under review at Climate Policy (Nicholson, Jinnah, and Gibeau) both offers a thorough review of the CE governance literature that you might find helpful and, importantly, offers a comprehensive and comprehensive analysis on various governance frameworks. Specifically, it overlays the literature on governance design with that of CE governance, ultimately arguing for a polycentric governance framework for this issue. [Michael Thompson, United States of America]

Taken into account. This paragraph extended with new literature and rewritten.
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>11101</td>
<td>39</td>
<td>38</td>
<td>40</td>
<td>9</td>
<td>The text is right to note that governance of SRM presents challenges that are quite distinct from those that apply to mitigation and adaptation. However, the content that follows gives the impression that institutional solutions are both obvious and clearly delineated. In contrast, research on governance of solar geoengineering, with regard to both field experiments and possible deployment, is only now getting underway and there is little agreement as to which architectures would be most viable and effective. Only one comprehensive research governance proposal (Hubert and Rechenthin 2015) has been advanced, while proposals for governance of SRM deployment have been fragmentary and incomplete. The text suggests that there are these possible governance arrangements for SRM—multilateral, unilateral, and bilateral—but the underlying scope and scale of governance mechanisms that scholars have put forward (e.g., Lloyd and Oppenheimer 2014; Weitzman 2015). The text also indicates that unilateralism is the most serious governance issue confronting SRM, yet the severity of this problem has been disputed (Horton 2011; Parson and Ernst 2013) and many observers consider the potential for SRM to undermine mitigation efforts the so-called “moral hazard” problem to be the most challenging governance problem associated with solar geoengineering.</td>
</tr>
<tr>
<td>16424</td>
<td>39</td>
<td>40</td>
<td>40</td>
<td>30</td>
<td>Change “cheap” to “inexpensive” or “low cost”</td>
</tr>
<tr>
<td>20413</td>
<td>39</td>
<td>40</td>
<td>40</td>
<td>49</td>
<td>How cheap is it to believe that the long-term commitment to SRM is considered?</td>
</tr>
<tr>
<td>13296</td>
<td>39</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>I suggest adding more recent references than one from 2006.</td>
</tr>
<tr>
<td>16436</td>
<td>39</td>
<td>40</td>
<td>40</td>
<td>41</td>
<td>Any unilateral action that happened would certainly be considered the hallmark of negative effects and tradeoffs, just doing so on a different framing, so the sentence needs modification. I’d also note that the ICFRF paradigm, coping anywhere will contribute to at least a bit of cooling everywhere, and so it is not all clear that the impact on others would be adverse.</td>
</tr>
<tr>
<td>11863</td>
<td>39</td>
<td>41</td>
<td>41</td>
<td>42</td>
<td>White deployment is technologically feasible for a number of states, it favors serious geopolitical feasibility constraints, which should be acknowledged along with the concerns about unilateral and multilateral deployment.</td>
</tr>
<tr>
<td>16427</td>
<td>39</td>
<td>42</td>
<td>43</td>
<td>43</td>
<td>Regarding the need for governance of field experiments, I know of no proposed field experiments that have been postulated to have a significant effect on other parties—indeed, the proposed experiments are all considerably smaller than the influences of analogous situations going on without objection. There has been no proposal for a stratospheric experiment that puts in anywhere near as much material as aircraft flights are injecting all the time, much less the amounts of injected material from small volcanic eruptions, the effects of which have not or these barely been detected; similarly with regard to proposed cloud experiments, all is far smaller than what is going on all the time as a result of the many thousands of freeways plying the oceans. The whole issue arises, in my opinion, due to either an overall anxiety to the idea of SRM or potential implementation of SRM in a sudden large burst, which is not the implementation strategy that would be appropriate for what is considered in this report. For the situation the report is talking about, a slow, iterative application in what makes sense—unfortunately, this type of application has simply not been much discussed in the various reports in the literature.</td>
</tr>
<tr>
<td>15692</td>
<td>39</td>
<td>43</td>
<td>43</td>
<td>47</td>
<td>Governance of geoengineering MUST be in place before any outdoor experimentation proceeds. Field experiments could lead to dangerous technological “lock-in.” See Oldham et al.</td>
</tr>
<tr>
<td>15444</td>
<td>39</td>
<td>43</td>
<td>43</td>
<td>49</td>
<td>Governance of geoengineering MUST be in place before any outdoor experimentation proceeds. Field experiments could lead to dangerous technological “lock-in.” See Oldham et al.</td>
</tr>
<tr>
<td>1003</td>
<td>39</td>
<td>44</td>
<td>44</td>
<td>44</td>
<td>Are there no proofs nowhere, that “Regional” SRM from MCB or cirrus clouds could be done or even exist? Delete the paragraph [Elenita Daño, Philippines].</td>
</tr>
<tr>
<td>15693</td>
<td>39</td>
<td>46</td>
<td>46</td>
<td>49</td>
<td>There are no proofs nowhere, that “Regional” SRM from MCB or cirrus clouds could be done or even exist. Delete the paragraph [Elenita Daño, Philippines].</td>
</tr>
<tr>
<td>15445</td>
<td>39</td>
<td>46</td>
<td>46</td>
<td>49</td>
<td>There are no proofs nowhere, that “Regional” SRM from MCB or cirrus clouds could be done or even exist. Delete the paragraph [Elenita Daño, Philippines].</td>
</tr>
<tr>
<td>16428</td>
<td>39</td>
<td>46</td>
<td>46</td>
<td>49</td>
<td>Is it not clear if SRM can be successfully employed locally and at scale. Perhaps the reference is meant to avoid not employing SRM locally for fear of affecting outside the target region when it may be a very viable tool for regional cooling especially over tundra, sea ice and glaciers (Miehe Kinn, United Kingdom (of Great Britain and Northern Ireland)).</td>
</tr>
</tbody>
</table>

**IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4**
The Draft’s sole paragraph outlining different governance models only cites one piece, Sander 2017 (Review of International Organizations), which is a game theory piece arguing for attention to security concerns with a fairly limited discussion of this governance option more broadly. Although an important contribution to the literature, pridigging this piece in your discussion of SRM governance design is insufficient. One piece currently under review at Climate Policy (Nicholson, Jinnah, and Gillespie) both offers a thorough review of the CE governance literature that you might find helpful and, importantly, offers a comparative and comprehensive analysis on various governance frameworks. Specifically, it overlays the literature on governance design with that of CE governance, ultimately arguing for a polycentric governance framework for this issue. [Sikina Jinnah, United States of America]

16429
39
51
40
3

With respect to potential winners and losers, it really does need to be without SRM, the consequence for virtually all situations would be very large and negative. What SRM, of many types of interventions, would do is to take conditions back toward the unparaphrased state such that it would be unlikely for any country to have very large and negative as for the GHG alone situation. Yes, all of countries would get back precisely to unparaphrased situation, but virtually all countries would be winners with respect to not undertaking SRM. There would just not be all be corrected to the same extent, so there would be some conceivable winners and losers, but with a much smaller magnitude than with respect to no SRM at all. In the statement here, there is no indication of what the reference is to, and that is essential. Being reasonably bespoke the field, my sense is this criticism of winners and losers is not with respect to the GHG performatation and for cases of very large changes. Also, for the relatively limited magnitude of SRM likely for the pathways considered in this report, so slicing off the temperature in excess of some level at 1.5°C or below, this effect would be small. Not making clear what the probable use of SRM would be, its magnitude, etc., and what the comparison is being made with respect to areas all shortcomings of the discussion here. [Michael MacCrone, United States of America]

20491
39
54
40
1

Note the contrast between the assertion here that “it is likely” that there will be SRM winners and losers and the claim in Chapter 3 p120 line 33 that winners and losers are “excessive.” Also note that the supporting references for the claim here are entirely different to those of the Chapter 3 claim. Also note that, in these references, Rollins 2017, Rie Hegel and Silliman 2009 in the previous case, is also a personal commentary [e.g. 2014 looks specifically at SRM in the context of stabilizing the climate under an IPCC-S5 scenario and finds that, in general, there is a lot more winners than losers. “Comparison of regional features of temperature and precipitation fields with and without stabilization of global temperatures shows that the use of SRM could reduce or, at least, would not increase the value of regional anomalies in most regions in contrast to the case of uncontrolled growth of global temperature. It would be possible to find a compromise between growth of temperature and intensity of precipitation both on a global and regional levels.”]. Hayen et al 2015 argues specifically against the assumption that “change is bad”, saying that it is not possible to make strong statements about winners and losers without an understanding of the different preferences of different actors and more sophisticated damage functions. I would suggest replacing “it is likely” with “it is quite possible.” [Oliver Morton, United Kingdom (of Great Britain and Northern Ireland)]

7811
40
2
40
2

There is no valid materials-availability concern, just the usual need for responsible mining practices. Lithium has proven abundant in quite a few countries. There are no valid rare-earth concerns either (Louvies, “Clean energy and rare earths: Why not to worry?” Bull. atom. Scient., 24 May 2017, http://thebulletin.org/clean-energy-and-rare-earths-why-not-worry10785). And new rechargeable alkali battery chemistries using toxic Materials. solid polymer electrolyte, notably MnO2/Al, have 1–3 Li-ion energy densities with ~5% the materials cost, mower manufacturing cost, and no offsetting liabilities; the same electrolyte permits other chemistries containing nothing rare, toxic, or flammar. [Oliver Morton, United Kingdom (of Great Britain and Northern Ireland)]

7055
40
2
40
2

There is no valid materials-availability concern, just the usual need for responsible mining practices. Lithium has proven abundant in quite a few countries. There are no valid rare-earth concerns either (Louvies, “Clean energy and rare earths: Why not to worry?” Bull. atom. Scient., 24 May 2017, http://thebulletin.org/clean-energy-and-rare-earths-why-not-worry10785). And new rechargeable alkali battery chemistries using toxic Materials. solid polymer electrolyte, notably MnO2/Al, have 1–3 Li-ion energy densities with ~5% the materials cost, mower manufacturing cost, and no offsetting liabilities; the same electrolyte permits other chemistries containing nothing rare, toxic, or flammar. [Oliver Morton, United Kingdom (of Great Britain and Northern Ireland)]

15659
40
4
40
9

It is striking that no reference has been made at all to the decision of the Conference of Parties of the Convention on Biological Diversity (CBD) in 2008 for a moratorium on ocean fertilization (later complemented by a set of Guidelines adopted by the London Convention/Protocol) and adoption of a de facto moratorium on all climate-related geoengineering in 2010. These decisions (also cited in Bodaney 2013) constitute the foundation and starting point of any discussion on global governance of geoengineering. [Encomm.Dano, Philippines]

15451
40
4
40
9

It is striking that no reference has been made at all to the decision of the Conference of Parties of the Convention on Biological Diversity (CBD) in 2008 for a moratorium on ocean fertilization (later complemented by a set of Guidelines adopted by the London Convention/Protocol) and adoption of a de facto moratorium on all climate-related geoengineering in 2010. These decisions (also cited in Bodaney 2013) constitute the foundation and starting point of any discussion on global governance of geoengineering. [Encomm.Dano, Philippines]
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>6772</td>
<td>40</td>
<td>4</td>
<td>40</td>
<td>9</td>
<td>The United Nations per se is not the only example of a globally-relevant international body that could take on governance of such activities - the UN has many agencies and other bodies that could have the authority for such governance and regulation, and that need not take long periods of time. As an example, the Parties to the London Convention and London Protocol, hosted by IMO as an UN body, agreed on the policy approach relating to ocean fertilization within 18 months of the statement of concern by scientists, on a framework for assessment within 24 years and on amendments to legal text within 3. It has yet to enter into legal force, but the decisions have had force in policy and political terms since the initial policy was agreed. The London Protocol amendments are also prepared so as to make possible the regulation of other marine geoengineering activities in the future, without the need for further change to the Protocol itself but only to its Annexes. This provides both a mechanism and a model for quite rapid adaptive governance. (Javander Morgen, Netherlands)</td>
</tr>
<tr>
<td>16430</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>Indeed, international agreements can be very time consuming, likely so time consuming that the only possible use of SRM would be late in the warming pathway when very adverse level to proposals for very SRM large interventions. While this is the typical scenario being studied, it is really not at all optimal if scientifically compared to a scenario with gradual increase of SRM that is phased up. And suggestions that one could establish an international governance structure be in place before any outside-the-lab experiments would likely rule out SRM at any time given the difficulty of making this happen—and no field experiments have been proposed that are anything close to having a large effect compared to natural or human analogs to the proposed approaches that are going on continuously. In my view, there are enough mechanisms in place for reviewing the research and initial research should focus on moving toward testing and early implementation to limit large regional impacts (see MacCracken, M.C., 2016; The rationale for accelerating regionally focused climate intervention research, Earth's Future, 4, 469-477, doi:10.1002/2015EF000450) before moving toward potential global intervention to limit temperature overshoots rather than waiting until the temperature increase and resulting impacts are so large that SRM is the only possible response. (Michael MacCracken, United States of America)</td>
</tr>
<tr>
<td>9093</td>
<td>40</td>
<td>13</td>
<td>40</td>
<td>24</td>
<td>The authors should not base all the cost estimates equally. More likely, the authors should take into account costs of the two main categories of costs (a) fixed costs and (b) variable costs. The fixed costs are the costs that are incurred regardless of the amount of SRM activity, while the variable costs are the costs that vary with the amount of SRM activity. The fixed costs include the costs of setting up the infrastructure and the costs of hiring personnel. The variable costs include the costs of running the equipment and the costs of storing and transporting the materials. (Sander 2019)</td>
</tr>
<tr>
<td>20414</td>
<td>40</td>
<td>13</td>
<td>40</td>
<td>25</td>
<td>I think that these cost estimates need to be looked at more critically. Who believes 225B may be obtained at the global scale for 38 million USD annually? That is the number that IPCC budget with in-kind contributions from the countries included… (Oliver Boucher, France)</td>
</tr>
<tr>
<td>16431</td>
<td>13</td>
<td>13</td>
<td>40</td>
<td>25</td>
<td>Again, these costs are for relatively large SRM implementations after warming and impacts have become so large that there are demands to do something and somewhere it is thought that a sudden 2 W/m² is needed will not have its own quite significant impacts from the rapid intervention. For the pathways described in this report where the overshoot is envisioned as gradually growing and then being brought under control by various mitigation actions, using SRM to shave off overshoot warming (so gradually phasing SRM up and then down), the costs would likely be significantly less than indicated here. It is really a shame that this section has not laid out the peak-shaving type of intervention, particularly because it could be iteratively implemented learning along the way, instead of the large and sudden intervention type of intervention considered in much of the literature, especially that cited here. (Michael MacCracken, United States of America)</td>
</tr>
<tr>
<td>1027</td>
<td>40</td>
<td>14</td>
<td>40</td>
<td>14</td>
<td>change. “Have we not cost the years and (feedback) to ‘behave quite consistent between’” (Alan Robock, United States of America) Accepted, text reviewed</td>
</tr>
<tr>
<td>1865</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>“MC 1680-79 at signs/monitoring and baseline” (Michael MacCracken, United States of America)</td>
</tr>
<tr>
<td>1898</td>
<td>40</td>
<td>16</td>
<td>40</td>
<td>16</td>
<td>“$0.235-3.40 billion. What does this mean? $0.235 to $30 billion? $0.235 billion to $30 billion? If the latter, write it as $253,000,000 to $30,000,000,000” (Alan Robock, United States of America) Noted, this paragraph was shortened and simplified</td>
</tr>
<tr>
<td>18453</td>
<td>14</td>
<td>14</td>
<td>17</td>
<td>14</td>
<td>“G. B. Roberts and Northphones” into gray shaded Mondex field with “2012” (Milverton, United States of America) Editorial</td>
</tr>
<tr>
<td>18454</td>
<td>14</td>
<td>14</td>
<td>19</td>
<td>19</td>
<td>“M. B. Roberts et al. into gray shaded Mondex field with “2012” (Milverton, United States of America) Editorial</td>
</tr>
<tr>
<td>18432</td>
<td>40</td>
<td>23</td>
<td>40</td>
<td>25</td>
<td>This Miller construction cost and several carrying out PUB. Otherwise, please indicate how large or modest an effort is involved with the proposed $253,000,000 annual cost. (Michael MacCracken, United States of America) Noted, but we deleted this paragraph because only 1 study exists</td>
</tr>
</tbody>
</table>
13409 40 23 40 25
These operational costs depend on course of the magnitude of radiative forcing you are aiming to achieve with the MBR. Also these estimates are based on the use of very specific marine vessels. There are now discussions on the possibility of aircrafts, though this is not yet published. This cost analysis could be put into context of the 1.5°C target, for e.g. assume you want to cool from the different RCPs down to 1.5°C, and by taking the assumption from Saltz 2008. 1 ship cost 1-2 Gt of CO2, and 1000 ships would be needed for a radiative forcing of -0.7 W m^-2. It might be worth mentioning that one might expect substantial maintenance costs, since the spray filters are likely to get clogged up, and the ship lifetimes are relatively short. [Helena M. Noro].

16343 40 27 40 30
With respect to the true economic cost, this should really involve the savings from having reduced GHG impacts and not be focused on the remaining negative influences (so the costs of SRM not being perfect). Again, the correct assessment to be done is a comparison of the impacts of elevated GHG without SRM and the impacts of elevated GHG with SRM, and there are no indications that in making such a comparison that elevated GHG with SRM would have anywhere near the overall negative impacts of elevated GHG alone, it was even done, then one would not need to be doing SRM. It is true that during any research phase there could be a situation where testing may lead to relatively minor negative consequences (though no such experiment has yet been suggested) while the field experiment is so small there would not be global benefits, and this may make for a difficult decision, but this is roughly equivalent to suggesting one would not be doing any potentially negative medical testing on people in search of a medicine that would provide very large benefits. Society has learned how to move forward in such situations, and given the very severe prospective impacts of elevated GHG levels, taking some risk of slightly negative consequences in the research stage would seem to be justified if there is really potential to greatly reduce the severe impacts of elevated GHG levels. I just don’t see an adequate level discussion here of how realistic implementation of SRM might occur. [Michael MacCracken, United States of America].

16437 40 24 40 27
With respect to the true economic cost, this should really involve the savings from having reduced GHG impacts and not be focused on the remaining negative influences (so the costs of SRM not being perfect). Again, the correct assessment to be done is a comparison of the impacts of elevated GHG without SRM and the impacts of elevated GHG with SRM, and there are no indications that in making such a comparison that elevated GHG with SRM would have anywhere near the overall negative impacts of elevated GHG alone, it was even done, then one would not need to be doing SRM. It is true that during any research phase there could be a situation where testing may lead to relatively minor negative consequences (though no such experiment has yet been suggested) while the field experiment is so small there would not be global benefits, and this may make for a difficult decision, but this is roughly equivalent to suggesting one would not be doing any potentially negative medical testing on people in search of a medicine that would provide very large benefits. Society has learned how to move forward in such situations, and given the very severe prospective impacts of elevated GHG levels, taking some risk of slightly negative consequences in the research stage would seem to be justified if there is really potential to greatly reduce the severe impacts of elevated GHG levels. I just don’t see an adequate level discussion here of how realistic implementation of SRM might occur. [Michael MacCracken, United States of America].

1611 40 32 40 40
It needs to be pointed out that none of these studies address by the statement in lines 27-28. That is, they do not account for the potential negative impacts of geosequestration. Rather, they assume that they are zero because they cannot quantify them. This invalidates all of these analyses, and this needs to be pointed out in this report. [Alan Robock, United States of America].

1510 40 34 40 34
Economically optimal or suboptimal in economics jargon. What does it mean? [Alan Robock, United States of America].

16438 40 35 40 37
Noted. Majority of studies assess SRM approaches and their negative impacts separately, without comparison with World without SRM. Text revised a bit.

7912 40 37 40 37

7955 40 37 40 37

15406 40 31 40 37
Modern “manmade” and “souped-up” in grey shaded Hendry first with “2012” [Willem Middelburg, Oko, France].

18458 40 37 40 37

16340 40 24 40 24
change “need” to “needs” [Alan Robock, United States of America].

IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>7813</td>
<td>40</td>
<td>39</td>
<td>40</td>
<td>39</td>
<td>Most studies do not properly analyze and some do not even consider liquid hydrogen-fueled cryoplanes, yet they have been extensively designed (and some even tested) by Boeing, Airbus, Tupolev, NASA, and the US Air Force, among others. In general, as noted on my comments on p 4-20, line 37, they have found equal or better attributes compared to current kerosene-fueled airplanes. The further option of fuel cells and high-temperature-superconductor motors running unducted fans in H2-electric airplanes, noted in 2004 by Peeters (Loonstra et al. 2011, p 239 in 916), later turned out to offer ~5-7 x efficiency gains in commuter-range missions, and has been exploited in military aircraft now operating. In general, advanced biofuels and hydrogen are both realistic and worthy competitions for decarbonizing airplanes, heavy trucks, and ships, but all three offer massive efficiency opportunities—3x for trucks (Ogbum et al. 2008, Loonstra 2015, 2018), with 2x already demonstrated by industry in USDOD’s Supertruck program and succeeded in 2017 cross-country trials, probably 6x with even more-advanced Starman digital-value engines, and 10x fr ships, plus logistical improvements for all. I therefore feel that section 4.1.2.4.2’s pessimism and the message that biofuel substitution is the main option reflects today’s best understanding and practice of neither efficiency nor hydrogen competition. See generally Loonstra (2018). [Amory Lovins, United States of America]</td>
<td>Accepted. The whole section on airlines, shipping and storage has been rewritten in 4.3.2.</td>
</tr>
<tr>
<td>7907</td>
<td>40</td>
<td>39</td>
<td>40</td>
<td>48</td>
<td>Most studies do not properly analyze and some do not even consider liquid hydrogen-fueled cryoplanes, yet they have been extensively designed (and some even tested) by Boeing, Airbus, Tupolev, NASA, and the US Air Force, among others. In general, as noted on my comments on p 4-20, line 37, they have found equal or better attributes compared to current kerosene-fueled airplanes. The further option of fuel cells and high-temperature-superconductor motors running unducted fans in H2-electric airplanes, noted in 2004 by Peeters (Loonstra et al. 2011, p 239 in 916), later turned out to offer ~5-7 x efficiency gains in commuter-range missions, and has been exploited in military aircraft now operating. In general, advanced biofuels and hydrogen are both realistic and worthy competitions for decarbonizing airplanes, heavy trucks, and ships, but all three offer massive efficiency opportunities—3x for trucks (Ogbum et al. 2008, Loonstra 2015, 2018), with 2x already demonstrated by industry in USDOD’s Supertruck program and succeeded in 2017 cross-country trials, probably 6x with even more-advanced Starman digital-value engines, and 10x fr ships, plus logistical improvements for all. I therefore feel that section 4.1.2.4.2’s pessimism and the message that biofuel substitution is the main option reflects today’s best understanding and practice of neither efficiency nor hydrogen competition. See generally Loonstra (2018). [Amory Lovins, United States of America]</td>
<td>Accepted. The whole section on airlines, shipping and storage has been rewritten in 4.3.2.</td>
</tr>
<tr>
<td>16439</td>
<td>40</td>
<td>39</td>
<td>40</td>
<td>44</td>
<td>It is the potential global complexity of all that led me to urge that initial SRM be aimed at moderating specific regional impacts (see MacCracken, M. C., 2016. The rationale for accelerating regionalized, particularly climate intervention research, Earth Future 4, 649-657, doi:10.1002/2016EF000450). If one considers amplified Arctic warming, for example, this could be well considered first by the Arctic Council, which has a good history of engagement of Indigenous peoples of the region in decision processes. Also, with a focus on alleviating some particular regional impact, the metric for measuring success could be much more specific then can be associated with changes in the global average temperature. So, it seems to me that a much more reasonable consideration of SRM would be to think about starting at less than the global level—jumping from stong no SRM to stong global seems a very large jump, and it might well make sense to put a step in between where research and implementation are focused on determining if regional SRM can be successfully implemented before going global. [Michael MacCracken, United States of America]</td>
<td>Noted. Due to space limitations this paragraph was deleted</td>
</tr>
<tr>
<td>16132</td>
<td>40</td>
<td>42</td>
<td>40</td>
<td>42</td>
<td>2015 is not recent. [Alan Robock, United States of America]</td>
<td>Editorial</td>
</tr>
<tr>
<td>16343</td>
<td>40</td>
<td>42</td>
<td>40</td>
<td>47</td>
<td>Most of this analysis is for situations with relatively sudden and large SRM interventions, and indeed there can be potential issues with the type of intervention. For an implementation involving a gradual phasing up of SRM to offset overheating warming, the magnitude would be much like the effects of a slowly building volcanic eruption not too unlike what happened the first decade of this century, and the criticisms here are much less valid. So, again, it is really important to be taking about the type of intervention that is being discussed. [Michael MacCracken, United States of America]</td>
<td>Taken into account. Test revised to be related to overshoot scenario</td>
</tr>
<tr>
<td>16134</td>
<td>40</td>
<td>46</td>
<td>40</td>
<td>46</td>
<td>change “authors” to “the authors” [Alan Robock, United States of America]</td>
<td>Editorial</td>
</tr>
<tr>
<td>16440</td>
<td>40</td>
<td>46</td>
<td>40</td>
<td>48</td>
<td>With respect to the recommendation to “optimal compensation system of SRM,” again, while research and evaluation are done, it is essential to making sure the assessment is of elevated GHG without and with SRM, and if this is done, it would very much seem to me that the need for a compensation system applies very, very much more to the situation of elevated GHG without SRM than to elevated GHG with SRM. Unfortunately, much of the literature, for some reason, does not frame the evaluation in this way. I would hope that this report would do better in that, in the implementation approach envisioned for here should be for peak shaving rather than sudden and full reversal of all warming. [Michael MacCracken, United States of America]</td>
<td>Noted. We should assess peer-reviewed literature. This sentence was rewritten</td>
</tr>
<tr>
<td>16435</td>
<td>40</td>
<td>49</td>
<td>40</td>
<td>49</td>
<td>And there are no researchers in the SRM field who would support such a substitution. Not only does this do nothing for ocean acidification and imply a very long commitment to continuing SRM, but there are limits to the magnitude of SRM that is possible due to problems such as coagulation or stratospheric aerosols and suitable clouds for MCB, and so full substitution is just not likely to be even possible, much less sensible. [Michael MacCracken, United States of America]</td>
<td>Taken into account, we mentioned this</td>
</tr>
<tr>
<td>21183</td>
<td>40</td>
<td>49</td>
<td>40</td>
<td>50</td>
<td>The second sentence is not supported by the first [David Cooper, Canada]</td>
<td>Taken into account. Test revised</td>
</tr>
<tr>
<td>11013</td>
<td>40</td>
<td>49</td>
<td>40</td>
<td>51</td>
<td>Response to “There is no literature supporting the complete substitution of mitigation by SRM. This suggests that SRM would be used sparingly, which would decrease the potential side-effects, including the termination effect, and could address some of the societal issues (Sugiyama et al. 2017).” This reasoning is erroneous. The existence of such literature or lack of it does not necessarily restrain actions. The phrasing also seems misleading or biased since it does not mention that there are objections to even thinking of SRM as a viable option. See Gardiner, A. F. S. M. (2016). Why Geoengineering is not Plan B’. Justice and Geoscientificing 1, 1.</td>
<td>Taken into account. Test revised, but due to the space limitation we cannot add reference to the text</td>
</tr>
<tr>
<td>6775</td>
<td>40</td>
<td>49</td>
<td>40</td>
<td>51</td>
<td>The second sentence of the paragraph does not follow as a legitimate conclusion from the first. It is true that Sugiyama et al. (2017) have suggested that “one might choose to use SRM sparingly because of concerns surrounding environmental risks and social and ethical implications” and that “the side effects of SRM, including even the termination effect, and could potentially address some of the societal issues,” but this neither follows from an observation that no literature proposes complete substitution of mitigation by SRM, nor can be used to conclude that SRM “would be used sparingly” in practice. It is merely once possible scenario suggested by the authors of the paper cited. [Jennifer Morgan, Netherlands]</td>
<td>Taken into account. Test revised</td>
</tr>
<tr>
<td>Comment No</td>
<td>From Page</td>
<td>From Line</td>
<td>To Page</td>
<td>To Line</td>
<td>Comment</td>
<td>Response</td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>18436</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>55</td>
<td>'Finally, discussion of a plausible approach to SRM implementation: I think it would be very helpful to have such a discussion of potential types of SRM implementation up front, discussing sudden versus gradualized iterative implementation, limited temperature reduction rather than return to the 19th century baseline climate, long versus limited duration, global versus regional objectives, etc. and commenting that most of the research to date has focused on the types of implementation that are easiest to model rather than those that would make most potential and plausible signals from a policy perspective. It would also really help to indicate that raising the peak off the warming is an approach that would involve relatively modest SRM and could be phased out as CO2 is phased out. Such context for the discussion here is really needed, especially discussing the relationship of SRM (pace and relativity of cost effect and) CDR (slow and takes time to build up) but also helps on ocean acidification.' [Michael MacCracken, United States of America]</td>
<td>Taken into account. Test will describe possible scenarios of implementation</td>
</tr>
<tr>
<td>20492</td>
<td>40</td>
<td>40</td>
<td>51</td>
<td>52</td>
<td>'Some studies indicate for how much forcing or temperature reduction goal they prefer to see SRM. This is sufficiently inadequate as to border on the opaque. Some studies indicate preferred forcing or temperature-reduction goals for SRM might be preferable.' [David Cooper, Canada]</td>
<td>Accepted, text changed</td>
</tr>
<tr>
<td>18456</td>
<td>40</td>
<td>40</td>
<td>52</td>
<td>55</td>
<td>'Some studies indicate for how much forcing or temperature reduction goal they prefer to see SRM. This is sufficiently inadequate as to border on the opaque. Some studies indicate preferred forcing or temperature-reduction goals for SRM might be preferable.' [David Cooper, Canada]</td>
<td>Accepted, text changed</td>
</tr>
<tr>
<td>21194</td>
<td>40</td>
<td>40</td>
<td>52</td>
<td>52</td>
<td>'It is true that Keith &amp; MacCracken (2015) expressed the view that a small amount of deployment could make economic sense, but this should be presented in the proper context as an opinion from those authors, i.e. 'Keith &amp; MacCracken (2015) suggest that a small amount, etc.' [Jelmer Mangel, Netherlands]</td>
<td>Accepted, text was revised</td>
</tr>
<tr>
<td>11014</td>
<td>40</td>
<td>40</td>
<td>53</td>
<td>40</td>
<td>'Human rights need to fully integrated into this section. In particular there are examples to draw on for limits to human's ability to know the costs prior to deployment. As such, it is also inconsistent with the point embedded in the earlier question saying that the given uncertainties about impact of deployment of SRM on food security, such deployment is not feasible, observing principles of precaution.' [Michael Thompson, United States of America]</td>
<td>Accepted, this sentence deleted</td>
</tr>
<tr>
<td>6777</td>
<td>40</td>
<td>40</td>
<td>55</td>
<td>40</td>
<td>'Human rights need to fully integrated into this section. In particular there are examples to draw on for limits to human's ability to know the costs prior to deployment. As such, it is also inconsistent with the point embedded in the earlier question saying that the given uncertainties about impact of deployment of SRM on food security, such deployment is not feasible, observing principles of precaution.' [Michael Thompson, United States of America]</td>
<td>Accepted, this sentence deleted</td>
</tr>
<tr>
<td>18458</td>
<td>40</td>
<td>40</td>
<td>55</td>
<td>40</td>
<td>'Section 4.4: I suggest better linking these 'enablers' to specific options presented in 4.3. For example, under governance (4.4.3) there is a description of global, local, and community-based, with their respective case studies, but these can also include the specific mitigation or adaptation options referred to in 4.3.3 [Debora Ley, Guatemala]</td>
<td>Taken into account. Done</td>
</tr>
<tr>
<td>7919</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>'Enabling environments and transformational change. See Westphal and Theilade for important elements for transformation as identified in low-carbon economy case studies. Westphal and Theilade, 2016. &quot;Transformational Climate Finance: An Exploration of Low-Carbon Energies.&quot; (World Resources Institute.) [Westphal Michael, United States of America]</td>
<td>Taken into account. Thank you for a useful reference. It has not been included in favour of peer reviewed literature.</td>
</tr>
<tr>
<td>11003</td>
<td>41</td>
<td>3</td>
<td>41</td>
<td>41</td>
<td>'I suggest better linking these 'enablers' to specific options presented in 4.3. For example, under governance (4.4.3) there is a description of global, local, and community-based, with their respective case studies, but these can also include the specific mitigation or adaptation options referred to in 4.3.3 [Debora Ley, Guatemala]</td>
<td>Taken into account. Clarifications added</td>
</tr>
<tr>
<td>17681</td>
<td>41</td>
<td>3</td>
<td>41</td>
<td>49</td>
<td>'There is a lengthy discussion of the ethical issues surrounding SRM. SRM does raise ethical issues, but so do mitigation policies required to reach the 1.5°C target. Consider for example the use of intense hydraulic fracking, hydroelectric power, nuclear energy - these and other mitigation policies have all raised ethical issues. Or consider the implications of stranded fossil fuel assets for those whose livelihood depend on them for their livelihood. Or consider the fair distribution of global burdens to achieve greenhouse gas reduction targets. Or consider that if literature could be found that assesses social acceptability, trade-offs, and benefits...this is particularly the case for options that are well known and carry potentially very high costs if implemented (possibly for a reader to substitute an easier question like an untested technological solution for a harder / more complex known question). The options presented in section 4.3 would be more helpful to decision makers.' [Debora Ley, Guatemala]</td>
<td>Accepted, paragraph about ethics was added to CDR section (4.3.6). ethical issues of all mitigation technologies are addressing in chapter 5, but they don't cover SRM, so we are discussing them here</td>
</tr>
<tr>
<td>19729</td>
<td>41</td>
<td>3</td>
<td>41</td>
<td>49</td>
<td>'Can these issues of social acceptability and ethics also be explored for the previous sections on biocrude with CCS, REDD, direct capture and storage etc. ? Why are these issues only unpard for SRM? [Tara Shein, Ireland]</td>
<td>Taken into account. - Section 4.3.6 now features a new paragraph on ethics, noting that the ethics literature on CDR is extremely sparse compared to the ethics literature on SRM.</td>
</tr>
<tr>
<td>17682</td>
<td>41</td>
<td>3</td>
<td>41</td>
<td>49</td>
<td>'Consider the distribution of affordable distribution of greenhouse gases - see Caney 'Jilin Environmental Philosophy &amp; Public Affairs vol 40 no 4 (2012), pp 255-300. One widely shared view that is mitigation must honour human rights. See Caney 'Global Justice, Climate Change, and Human Rights: Theories and Global Practice' (Blackwell, 2012) edited by D. Holts and T. Williamson, 91-112 and Simon Caney 'Climate Change, Human Rights and Moral Thresholds' in Human Rights and Climate Change (Cambridge: Cambridge University Press, 2010), edited by S. Humprys, 89-90, (Simon Caney, United Kingdom of Great Britain and Northern Ireland).</td>
<td>Accepted, discussion about human rights exists in the text, but due to limited space we can't cover the topic in the detailed</td>
</tr>
<tr>
<td>19730</td>
<td>41</td>
<td>3</td>
<td>41</td>
<td>49</td>
<td>'Consider the distribution of affordable distribution of greenhouse gases - see Caney 'Jilin Environmental Philosophy &amp; Public Affairs vol 40 no 4 (2012), pp 255-300. One widely shared view that is mitigation must honour human rights. See Caney 'Global Justice, Climate Change, and Human Rights: Theories and Global Practice' (Blackwell, 2012) edited by D. Holts and T. Williamson, 91-112 and Simon Caney 'Climate Change, Human Rights and Moral Thresholds' in Human Rights and Climate Change (Cambridge: Cambridge University Press, 2010), edited by S. Humprys, 89-90, (Simon Caney, United Kingdom of Great Britain and Northern Ireland).</td>
<td>Accepted, discussion about human rights exists in the text, but due to limited space we can't cover the topic in the detailed</td>
</tr>
<tr>
<td>19731</td>
<td>41</td>
<td>3</td>
<td>41</td>
<td>49</td>
<td>'Consider the distribution of affordable distribution of greenhouse gases - see Caney 'Jilin Environmental Philosophy &amp; Public Affairs vol 40 no 4 (2012), pp 255-300. One widely shared view that is mitigation must honour human rights. See Caney 'Global Justice, Climate Change, and Human Rights: Theories and Global Practice' (Blackwell, 2012) edited by D. Holts and T. Williamson, 91-112 and Simon Caney 'Climate Change, Human Rights and Moral Thresholds' in Human Rights and Climate Change (Cambridge: Cambridge University Press, 2010), edited by S. Humprys, 89-90, (Simon Caney, United Kingdom of Great Britain and Northern Ireland).</td>
<td>Accepted, discussion about human rights exists in the text, but due to limited space we can't cover the topic in the detailed</td>
</tr>
<tr>
<td>20663</td>
<td>41</td>
<td>3</td>
<td>41</td>
<td>49</td>
<td>'Consider moving (and expanding) upon section 4.3.7.2.1 and maybe even moving it &quot;closer to the left hand margin.&quot; Social acceptability and ethics could arguably feature much stronger in chapter 4 (if the literature supports it). The options presented in section 4.3 would be more helpful to decision makers if literature could be found that assesses social acceptability, trade-offs, and benefits...this is particularly the case for options that are well known and possibly socially contested AND technological solutions that are perhaps not well known and carry potentially very high costs if implemented (possibly for a reader to substitute an easier question like an untested technological solution for a harder / more complex known question). The options presented in section 4.3 would be more helpful to decision makers if literature could be found that assesses social acceptability, trade-offs, and benefits...this is particularly the case for options that are well known and possibly socially contested AND technological solutions that are perhaps not well known and carry potentially very high costs if implemented (possibly for a reader to substitute an easier question like an untested technological solution for a harder / more complex known question). The options presented in section 4.3 would be more helpful to decision makers if literature could be found that assesses social acceptability, trade-offs, and benefits...this is particularly the case for options that are well known and possibly socially contested AND technological solutions that are perhaps not well known and carry potentially very high costs if implemented (possibly for a reader to substitute an easier question like an untested technological solution for a harder / more complex known question). The options presented in section 4.3 would be more helpful to decision makers if literature could be found that assesses social acceptability, trade-offs, and benefits...this is particularly the case for options that are well known and possibly socially contested AND technological solutions that are perhaps not well known and carry potentially very high costs if implemented (possibly for a reader to substitute an easier question like an untested technological solution for a harder / more complex known question).</td>
<td>Accepted, section 4.3 (on CDR) now features a new paragraph on ethics, noting that the ethics literature on CDR is extremely sparse compared to the ethics literature on SRM.</td>
</tr>
</tbody>
</table>

**IPCC WGI SR15 First Order Draft Review Comments And Review Responses - Chapter 4**

The paragraph on moral hazard should mention empirical work showing that the sign and magnitude of the moral hazard effect are both unclear. A key different issues as discussed by Preston (20130) and Chen & Xin (2017). [Jennifer Morgan, Netherlands] 

Conveyed in relation to 'moral hazard' etc. It would be worth expanding this paragraph with a bit more explanation rather than risk conflating quite the construction of the sentence on this in Chapter 4. In the context of the preceding sentence, it is currently difficult to grasp exactly what is being this point that could complement Chen and Xin’s analysis. [Sikina Jinnah, United States of America] 

Agreement. Chen and Xin call for SRM as an inevitable outcome of the Paris Agreement and encourages China’s development of such a program. I believe that the principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

ECOs, the European Commission’s strategy to achieve a competitive low-carbon economy by 2050, is an example of such a strategy. [Olivier Boucher, France] 

The following article might be worth citing here regarding the moral hazard and slippery slope arguments: Merk et al (2015), DOI 10.1007/s10584-014-1317-7 [David Morrow, United States of America] 

Noted, we discuss peer-reviewed literature and not doing our own research. But text will be revised a bit. 

SRM is thus not unique in not providing a return to a "natural" state. [Oliver Morton, United Kingdom (of Great Britain and Northern Ireland)] 

favour of SRM has little if any credibility. It is essentially an artefact of game theory approaches. [Jennifer Morgan, Netherlands] 

a world in which it is vital to tackle climate change as far as possible by dealing with emissions at source, the concept of "inefficient" levels of mitigation in climate action. SRM is thus not unique in not providing a return to a "natural" state. [Oliver Morton, United Kingdom (of Great Britain and Northern Ireland)] 

The draft relies heavily on Chen and Xin (2017) (Advances in Climate Change Research) to discuss the relationship between SRM and the Paris Agreement. Chen and Xin call for SRM as an inevitable outcome of the Paris Agreement and encourages China’s development of such a program. I would suggest a more nuanced and tempered discussion of the international politics surrounding SRM development and governance. Again, Nicholson, Jinnah, and Gillespie’s manuscript currently under review at Climate Policy, would also offer a far more balanced and measured voice regarding the institutional need for SRM (or not) than the primary piece currently relied on in the IPCC Draft report on this point. It also points to further literature on the point that could complement Chen and Xin’s analysis. [Brian Jankowski, United States of America] 

The paper by Moreno-Cruz (2015) is a highly abstracted theoretical treatment that sets the normative expectations against which mitigation actions are judged to be more or less efficient. It does not include consideration of the actual or relative risks to natural systems or human accretions arising from mitigation as opposed to SRM - rather the two appear in the author’s analysis to have complete equivalence in terms of environmental, social and moral acceptability. In reality, in a world in which it is vital to tackle climate change as far as possible by dealing with emissions at source, the concept of "inefficient" levels of mitigation in favour of SRM has little if any credibility. It is essentially an artefact of game theory approaches. [Jurjen Morgan, Netherlands] 

Noted, we accept the point but we have to be selective as to what literature to include to stay within the agreed page limit of the section. 

The draft relies heavily on Chen and Xin (2017, Advances in Climate Change Research) to discuss the relationship between SRM and the Paris Agreement. Chen and Xin call for SRM as an inevitable outcome of the Paris Agreement and encourages China’s development of such a program. I would suggest a more nuanced and tempered discussion of the international politics surrounding SRM development and governance. Again, Nicholson, Jinnah, and Gillespie’s manuscript currently under review at Climate Policy, would also offer a far more balanced and measured voice regarding the institutional need for SRM (or not) than the primary piece currently relied on in the IPCC Draft report on this point. It also points to further literature on the point that could complement Chen and Xin’s analysis. [Brian Jankowski, United States of America] 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

Noted, we accept the point but we have to be selective as to what literature to include to stay within the agreed page limit of the section. 

Noted, ethics section revised. David Keith, The Case for Climate Engineering (MIT Press, 2012) is not a peer-reviewed one and not one we are focusing mostly on literature after ARA (2013). 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

Noted, ethics section revised, issues of intergenerational equity mentioned.

Noted, we accept the point but we have to be selective as to what literature to include to stay within the agreed page limit of the section. 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France] 

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Elske Pietsche, France]
The question of governance of SRM is highly political, not technical, so asking for more research by the same that promote geoengineering is not useful.

How is the SRM related to the right of women?! [Yana POPKOSTOVA, France] accepted, text revised to right of human

The question of governance of SRM is highly political, not technical, so asking for more research by the same that promote geoengineering is not useful.

revision - “a compensation system for SRM” [Christopher Bataille, Canada] Editorial, text revised

those concerned with is extraneous. [Oliver Morton, United Kingdom (of Great Britain and Northern Ireland)] accepted, text revised, phrase deleted

Do Not Quote, Cite, or Distribute Page 107 of 159
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1214</td>
<td>41</td>
<td>54</td>
<td>45</td>
<td>19</td>
<td>The beginning of this section 4.4.1 is confusing. Are these 3 types of enabling environments useful? Why not start 4.4. with laying out what would be needed to implement far-reaching and rapid change? Enhancing governance may well become the first real sub-section here. (Petra Tschakert, Austria)</td>
<td>Accepted. The lay-up of Section 4.4.4 has been changed. 4.1 now much reduced and governance taken to sub-point on this topic.</td>
</tr>
<tr>
<td>12471</td>
<td>42</td>
<td>1</td>
<td>42</td>
<td>5</td>
<td>Please, consider adding to the paragraph the words it is noted. The far-reaching and rapid change required to remain below 1.5 C and allow societies to cope with the accelerated climate changes will depend on circumstances that enable and cohere innovations in technology (Creutzig et al. 2015), buildings and infrastructure (most obviously in urban areas) (Route et al. 2014;Roberta 2016b), finance (Campiglio 2016; Pauw 2017; Diet-Rayney et al. 2017), human behaviour (Steg 2016; Moloney et al. 2010) and mode of interaction in science-society interfaces (Vogel et al., 2007).</td>
<td>Taken in account. We are looking into it, but the sections in 4.4.4 are tremendously important as they are on how to implement these technologies.</td>
</tr>
<tr>
<td>20638</td>
<td>42</td>
<td>100</td>
<td></td>
<td></td>
<td>The later sections of the chapter take a lot of room compared to the discussion of technologies. This balance may need adjustment. (Jens Piwek, Germany)</td>
<td>Accepted. The section has been revised and the detail entitled to subsection sections.</td>
</tr>
<tr>
<td>18033</td>
<td>42</td>
<td>1</td>
<td>42</td>
<td>5</td>
<td>Please, consider adding to the paragraph the words it is noted. The far-reaching and rapid change required to remain below 1.5 C and allow societies to cope with the accelerated climate changes will depend on circumstances that enable and cohere innovations in technology (Creutzig et al. 2015), buildings and infrastructure (most obviously in urban areas) (Route et al. 2014;Roberta 2016b), finance (Campiglio 2016; Pauw 2017; Diet-Rayney et al. 2017), human behaviour (Steg 2016; Moloney et al. 2010) and mode of interaction in science-society interfaces (Vogel et al., 2007).</td>
<td>Taken in account. We are looking into it, but the sections in 4.4.4 are tremendously important as they are on how to implement these technologies.</td>
</tr>
<tr>
<td>7108</td>
<td>42</td>
<td>4</td>
<td></td>
<td>5</td>
<td>According to what logic is human behavior tied here in comparison to sections (technology, infrastructure, buildings, finance)? [Erika Mata, Sweden]</td>
<td>Accepted and section removed. The point is taken into account in Section 4.4.3 on behavioural change.</td>
</tr>
<tr>
<td>19732</td>
<td>42</td>
<td>23</td>
<td></td>
<td>11</td>
<td>The classification of the &quot;behavioral and lifestyle&quot; among other social components of the operative environment seems more logic to me. [Erika Mata, Sweden]</td>
<td>Accepted. Text has been amended to include the role of women in decision making and female partnerships.</td>
</tr>
<tr>
<td>7110</td>
<td>42</td>
<td>23</td>
<td>44</td>
<td>10</td>
<td>The classification could be more useful if key issues could be specified for sectors and regions. [Erika Mata, Sweden]</td>
<td>Accepted. Text expanded.</td>
</tr>
<tr>
<td>6037</td>
<td>42</td>
<td>29</td>
<td>42</td>
<td>29</td>
<td>The term 'accountable governance' here (as the comment further up) is rather too specific to warrant the claim. The key question is 'to whom' is governance accountable, and by what means are they held to account? Without knowing that, the claims made here for why accountability is important do not make sense. The other point made here in terms of enabling environments next generation would be from the literature on experimentation in climate governance - where the thing that enables more transformative shifts is a mode of governance focused on supporting novel innovations, experiments, see for example: Hoffmann, Mathew J. 2011. Climate Governance at the Crossroads: Experimenting with a Global Response after Kyoto. Oxford University Press; Bulkeley, Harriet, Vanesa Castán Broto, and Gareth Edwards. 2015. An Urban Politics of Climate Change: Experimentation and the Governing of Socio-Technical Translators. London: Routledge; Bulkeley, Harriet, and Vanesa Castán-Broto. 2013. Government by Experiment? Global Cities and the Governing of Climate Change. Transactions of the Institute of British Geographers 38:361–375. (Matthew Paterson, United Kingdom)</td>
<td>Accepted and text amended.</td>
</tr>
<tr>
<td>14091</td>
<td>42</td>
<td>40</td>
<td></td>
<td>40</td>
<td>Refer to the role of collective socio capital for adaptation and mitigation. This links also with trust, effective institutions, and community resilience. [Elena Poloczanska, Germany]</td>
<td>Noted. Text has been amended to include the role of trust and reciprocity. But no specific citation provided.</td>
</tr>
<tr>
<td>14092</td>
<td>42</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>For effective partnership working, actors don’t need to be shared in their entirety but there does need to be some shared purpose. There will be some differences and some similarities in-goals between the parties; ‘a shared vision’ implies a single goal held by all - this is not realistic and also not necessary [Elena Poloczanska, Germany]</td>
<td>Accepted. Text has been amended to reflect partnerships, characterized by a shared sense of risks and purpose.</td>
</tr>
<tr>
<td>19733</td>
<td>42</td>
<td>40</td>
<td>42</td>
<td>51</td>
<td>See the examples of women’s participation in decision-making which should be part of all partnerships. Plus methods to ensure gender balance in partnerships. [Tara Shine, Ireland]</td>
<td>Taken into account. Text has been amended to include the role of women in decision making and female education around climate change with references from peer reviewed literature (Aceitezaro et al. 2017; Lutz and Muttarak 2017; Warnell 2017).</td>
</tr>
<tr>
<td>6079</td>
<td>42</td>
<td>45</td>
<td>42</td>
<td>45</td>
<td>I see no national framing, no ‘farming’. [J. David Tabara, Spain]</td>
<td>Accepted. The lay-up of Section 4.4.4 has been changed. 4.1 now much reduced and governance taken to sub-point on this topic.</td>
</tr>
<tr>
<td>18468</td>
<td>55</td>
<td>52</td>
<td>55</td>
<td>55</td>
<td>Enhanced gender literacy needed to implement far-reaching and rapid change? Enhancing governance may well become the first real sub-section here. (Petra Tschakert, Austria)</td>
<td>Accepted and section removed. The point is taken into account in Section 4.4.3 on behavioural change.</td>
</tr>
<tr>
<td>20252</td>
<td>43</td>
<td>3</td>
<td>43</td>
<td>6</td>
<td>Why immediately the urban focus? What about urban-rural linkages, predominance of poverty in rural areas in many countries all e.g. (e.g. many countries in Africa)? [Pernille Ulsang, South Africa]</td>
<td>Noted. Text has been amended to include the role of women in decision making and female education around climate change with references from peer reviewed literature (Aceitezaro et al. 2017; Lutz and Muttarak 2017; Warnell 2017).</td>
</tr>
<tr>
<td>2700</td>
<td>43</td>
<td>3</td>
<td>43</td>
<td>6</td>
<td>[Michelle Leslie, Canada]</td>
<td>Accepted and text revised with references from peer reviewed literature (Aceitezaro et al. 2017; Lutz and Muttarak 2017; Warnell 2017).</td>
</tr>
<tr>
<td>4108</td>
<td>43</td>
<td>8</td>
<td></td>
<td>14</td>
<td>Female education can also include out of classroom education for older women as well. [Michelle Leslie, Canada]</td>
<td>Accepted and text revised with references from peer reviewed literature (Aceitezaro et al. 2017; Lutz and Muttarak 2017; Warnell 2017).</td>
</tr>
<tr>
<td>10254</td>
<td>43</td>
<td>8</td>
<td></td>
<td>14</td>
<td>The paragraph is very poorly written. It deserves far more attention. [Bente Zimke, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accepted - text revised.</td>
</tr>
<tr>
<td>Comment No</td>
<td>From Page</td>
<td>From Line</td>
<td>To Page</td>
<td>To Line</td>
<td>Comment</td>
<td>Response</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-----------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>1540</td>
<td>43</td>
<td>8</td>
<td>43</td>
<td>14</td>
<td>Section 4.4.1.1 Dynamic features of enabling environments page 4-43, line 8-14</td>
<td>Accepted and text revised.</td>
</tr>
<tr>
<td>1396</td>
<td>43</td>
<td>8</td>
<td>43</td>
<td>14</td>
<td>While important for creating an environment conducive to achieving a 1.5°C world, public education alone is not enough — other biases and mental heuristics must be addressed, as shown by e.g. Hamilton, L.C. (2011), “Education, politics, and opinions about climate change evidence for interaction effects.” [Colin Raymond, United States of America]</td>
<td>Accepted. Included in new section on science policy interface and communication.</td>
</tr>
<tr>
<td>11179</td>
<td>43</td>
<td>8</td>
<td>43</td>
<td>14</td>
<td>This section on climate education also seems to consider the impacts of climate change on education, to elaborate on the point “there are strong two-way links between female education and climate risk” [Michiel Schaeffer, Netherlands]</td>
<td>Accepted. This is an introductory section. Role of education now given greater prominence in a new sub-section of 4.4.</td>
</tr>
<tr>
<td>1472</td>
<td>43</td>
<td>8</td>
<td>43</td>
<td>14</td>
<td>Education is currently given scant coverage as an enabling mechanism for all of the stressors considered in this chapter. Space alloving, I would urge the authors to expand this section/enhance other related sections, to highlight the role of education in terms of all elements of climate change capacity, building from school-level educational education helping to support individual behaviour change, through formal technical training, to high-level climate education to support academic, government, private sector and NGO leadership in all nations. Knowledge-sharing is flagged up, but is not given sufficient weight in my view. Reference should be made to the Peer Committee on capacity-building, as well as more case of examples of city-city collaborations and similar sub-national programmes (e.g. SIPEHER programme [DCRF] in the UK). [David Reay, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accepted. Lutz reference very useful and added.</td>
</tr>
<tr>
<td>15306</td>
<td>43</td>
<td>13</td>
<td>43</td>
<td>13</td>
<td>While the assumption that female education is linked to climate risk is made sparingly throughout the text, and indeed there is some literature examining such an interrelationship, in this report, the statement stands without any weight and is repeated without the support of one factual example/note/strong/different and the reader is left with his/her own assumptions on what this relationship could be. The argument needs to be bolstered by an example. [Yana POKROPOVSKAYA, France]</td>
<td>Accepted. Citations added and text revised.</td>
</tr>
<tr>
<td>9345</td>
<td>43</td>
<td>13</td>
<td>43</td>
<td>14</td>
<td>In addition to the emphasis on “better educated communities are more enabled to adapt and take long-term decisions regarding their futures,” the need to better integrate sustainable development principles into education is also receiving attention. Recent publications from the literature include: Walker-Lead Filho et al., Implementing climate change research at universities: Barriers, potential and actions. Journal of Cleaner Production Volume 170, 1 January 2018, Pages 269–277 <a href="https://doi.org/10.1016/j.jclepro.2017.08.105">https://doi.org/10.1016/j.jclepro.2017.08.105</a> as well as Walker-Lead Filho et al., Identifying and overcoming obstacles to the implementation of sustainable development at universities. Journal of Integrative Environmental Sciences Volume 14, 2017 – Issue 1 <a href="http://www.mrfcj.org/wp-content/uploads/2015/09/Education-for-Climate-Justice.pdf">http://www.mrfcj.org/wp-content/uploads/2015/09/Education-for-Climate-Justice.pdf</a> [Tara Shine, Ireland]</td>
<td>Accepted and text revised.</td>
</tr>
<tr>
<td>10225</td>
<td>43</td>
<td>17</td>
<td>43</td>
<td>17</td>
<td>Community engagement (local projects) is also important. [Mirtxekin Zinka, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Published.</td>
</tr>
<tr>
<td>19737</td>
<td>43</td>
<td>18</td>
<td>43</td>
<td>23</td>
<td>add a reference to the right to participation and to article 10 of the Rio Convention and article 6 of the UNFCCC [Tara Shine, Ireland]</td>
<td>Noted but specific reference is not included. The sections on rights framework has been expanded. Not the purpose of this report to cite UNFCCC. Focus is on post-2015 literature.</td>
</tr>
<tr>
<td>20253</td>
<td>43</td>
<td>18</td>
<td>43</td>
<td>23</td>
<td>Promoting a trustworthy means of communicating the importance of alignment of public awareness in local communities, policy driven change, technological efficiencies and economic and finance factors is vital – the present channels have proved inadequate. [Martin Rees, Norway]</td>
<td>Accepted. Included in new section on science policy interface and communication.</td>
</tr>
</tbody>
</table>
### Section 4.1.2 Systemic approaches

<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>6990</td>
<td>43</td>
<td>18</td>
<td>43</td>
<td>23</td>
</tr>
<tr>
<td>11160</td>
<td>43</td>
<td>19</td>
<td>43</td>
<td>21</td>
</tr>
<tr>
<td>10560</td>
<td>43</td>
<td>23</td>
<td>47</td>
<td>35</td>
</tr>
<tr>
<td>11181</td>
<td>43</td>
<td>25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


- **Response:** Accepted. This is an important point that is reflected in the revised text. The specific Tabara citation has not been used (there is a strong emphasis in this report on literature since AR5) but may be considered under Section 4.3.4 on behaviour change and 4.3.1 on feasibility. enabling environment.

#### The decoupling of emissions and economic growth in select economies...is enabled by a growing social concern around climate change that generates incentives for policy and technological change... [Michiel Schaeffer, Netherlands]"

- **Response:** Accepted - text revised.

#### This whole section is very general, and not backed by any scientific or conceptual discussions. You may remove all together. [Jose Antonio Puppim de Oliveira, Brazil]

- **Response:** Rejected. This section is being re-drafted for SOD, based on the most recent and relevant literature.

### Section 4.1.2 Systemic approaches

**Comments:** In my opinion, the paragraph should elaborate more on integration of adaptation, mitigation. Currently the provided information are not clear. Particularly, the box 4.4 does not have strong connection with the content of the paragraph. I would suggest providing an example of a joint adaptation and mitigation (JAM) strategy first in detailed and then discussing on its integration with Development and SDG's (e.g. climate smart agriculture presented by Gonzalo et al. 2017 or Nilsson et al. 2016 which present the interactions between sustainability development goals mainly).

- **Response:** Taken into account. The specific references have not been used but the broader points are reflected in the substantially revised text.

---

**Include references / mention of the developments of a Global Circular Economy and transition from a Linear to a Circular system e.g: (source adapted from: http://www.easac.eu/fileadmin/Reports/Easac_15_CE_web_corrected.pdf )**

- **Response:** Accepted - text revised. Circular economy is not specifically mentioned in revised text, but has been adopted in 4.3.4 (Ukraine).

---

**The following lines could be considered potential addition for section 4.1.2 Systemic elements of enabling environments Line 25-34**

- **Response:** Accepted. This is an important point that is reflected in the revised text. The specific Tabara citation has not been used (there is a strong emphasis in this report on literature since AR5) but may be considered under Section 4.3.4 on behaviour change and 4.3.1 on feasibility. enabling environment.

---

**To address specific issues such as climate change, ocean acidification, loss of natural ecosystems, and degradation, species extinction, water supply and shortages, so should not be derived from the many separate and targeted national and international policies on those issues. Current arguments in support of the circular economy point to continued growth in population and per capita consumption and thus increasing demands both for renewable and non-renewable resources, which have led to an environmental footprint for humanity that is unsustainable (H-okstra and Wiedmann, 2014). According to UNEP (2012) analyses, consumption already exceeds several critical global, regional and local thresholds: a consumption also reached by analysts of the planetary boundaries which should not be exceeded to ensure a sustainable future for humanity (Rockström et al., 2009; Steffen et al., 2015). [Geraldine Ann Cusack, Ireland]"**

- **Response:** Accepted - text revised. Circular economy is not specifically mentioned in revised text, but has been adopted in 4.3.4 (Ukraine).

---

**Leadership is helpful but not essential in International Relations; an alternative (perhaps more viable because it needs less political courage) is the creation of 'winning' coalitions, coalitions strong enough to force others to comply or adapt. [Mersal Wiesenburg, Netherlands]**

- **Response:** Noted. But no reference to peer-reviewed literature provided. The Geels et al (2017) paper makes similar point and is adopted.
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
14094 | 1 | 4 | | | Explaining the term 'sun-rise' and 'sun-well sectors. (Exhla Polsitizemana, Germany) | Noted. This is a glossary term. |
18034 | 43 | 49 | 43 | 53 | Please, consider adding to the paragraph. Climate Services aims to provide different kinds of decision-makers with usable and actionable information on climate variability, climate change impacts and its related risks, opportunities and uncertainties (EC – Climate Services Roadmap). To labor climate products to the various needs of users more intensive forms of knowledge exchange and collaboration across traditionally divided science-practice-policy communities is essential (Lemos and Morehouse, 2005; Herding et al., 2014; Lourenzo et al., 2015). | Accepted. New reference is to science-policy interface more generally. |
765 | 43 | 49 | 43 | 53 | The paragraph highlights the need for knowledge partnerships, the citation mention "natural and social sciences" as well as economists. However one of the main causes of man made GHG emmissions are machines and processes invented and operated by engineers. The technology uses energy and resources. Therefore where do they fit in the mix of knowledge partnerships to help provide input to the "collaging and complex transition"? They need to be added to the mix of experts and included in climate change policy and literature. The same applies to page 29 lines 4-5. (Mike Monk, United Kingdom (of Great Britain and Northern Ireland)) | Accepted. Climate services point now included as link between data and action. |
12472 | 44 | | | | More for authors is required to take World Climate Day 11th of March. It looks authors are creating new info rather than assessing existing literature and even looking previous IPCC AR. [Dr Noim UDDIN, Australia] | Taken into account but citation not used as section tries to focus on peer reviewed literature. |
19738 | 44 | 1 | 44 | 3 | This section on a durable rights framework should be expanded - drawing on the work of OHCHR, UNEP (and Columbia Law School), the Mary Robinson Foundation for Climate Justice. To labor climate products to the various needs of users more intensive forms of knowledge exchange and collaboration across traditionally divided science-practice-policy communities is essential (Lemos and Morehouse, 2005; Herding et al., 2014; Lourenzo et al., 2015). | Accepted with new reference to procedural justice and climate change responses. We have related to peer reviewed literature. |
5132 | 44 | 1 | 44 | 3 | The reference to a durable rights framework is welcome, and this should be expanded to include an explicit mention of the role of a rights framework in the process of identifying, prioritising, and implementing climate action in the context of the SDGs. Navigating trade-offs (a challenge highlighted in Section 4.4.2) will require government and others to adhere to rights frameworks in the process of climate action planning. While we may share broad-based outcomes as our goals (i.e. the SDGs & the goals of the Paris Agreement), the likely need for trade-offs indicates that UNHCR have achieved these goals as is as important as achieving its goals themselves. Process will matter. [Yosra Raeya, United States of America] | Accepted with new reference to procedural justice and climate change responses. |
18035 | 44 | 10 | 44 | 14 | Please, consider adding to the paragraph. Climate adaptation services can bridge the gap between the sources of climate-related information and the local spatial adaptation planning through integrated decision support tools that include vulnerability assessment and the design and appraisal of adaptation options (e.g. Goosen et al., 2013). | Accepted. Climate services point now included as link between data and action. |
27511 | 44 | 5 | 44 | 5 | Critical to link this with the need to receive policy fragmentation and sectoral policies that work against one another and this end goal. [Henry Uhrlin, South Africa] | Noted. Tool has been substantially revised to reflect this point in this and other sections (see 4.3.1) |
10205 | 44 | 11 | | | Fighting climate change denial: Paid deniers and falsehoods on climate change matters could and should be considered as Crime Against Humanity at the highest level. An international court for Climate could be created to give an international impetus to this. [Beat Brunner, Switzerland] | Rejected on the grounds that this would be “policy prescriptive”. Section on “rights frameworks” has been enhanced and reviewed. |
10206 | 44 | 11 | | | Allowing rights to harness the solar energy on your roof and facades and environmental heat in the air and ground without need for permitting as long as national noise standards to not disturb neighbors at night are met inside your own land would help a lot moving to renewable energies for electricity, heating and hot water. [Beat Brunner, Switzerland] | Noted and text amended in 4.3.4. Although the specific point is not mentioned in favour of broader enabling environment legislation, energy governance and building standards. |
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>10937</td>
<td>44</td>
<td>11</td>
<td></td>
<td></td>
<td>Another proposal recommendation to governments and institutions. (When communicating about climate change: 1. Do not use future, but present: climate change is now. 2. Use short term dates: 2018, 2020, maybe 2022. Do not talk about fan-looking dates like 2050 or 2100. Most of us will be dead by then so nothing happens.) 3. When setting long-term goals, like 2050 or 2060, set interim goals for the quarter, and next quarter, and next years. Otherwise nothing happens. 4. The report should also have in the actions chapter (7) a page list of immediate actions for governments: Right now, after reading chapter 4, it is overwhelming, and it's our duty to recommend immediate actions, that are clear and easy to enact. We need also an executive summary of the executive summary, with graphs, nicely laid out and appealing to read. Right now the series of seminar-long paragraphs over several pages in the executive summary look daunting and do not entice to read them. A graphics designer could help there. And also grouping by captions. (Beat Brunner, Switzerland)</td>
<td>Rejected on grounds that this would be “policy prescriptive”. General point about communication and behaviour change is noted in the revised text.</td>
</tr>
<tr>
<td>7111</td>
<td>44</td>
<td>14</td>
<td>45</td>
<td>20</td>
<td>Could the examples in Box 4.1 and 4.2 be assigned as representative of a particular segment or categorization of implementation environments, in order to facilitate replicability? (Erika Klaas, Sweden)</td>
<td>Accepted. To be discussed with CLAs for better categorization to facilitate replicability.</td>
</tr>
<tr>
<td>17744</td>
<td>44</td>
<td>32</td>
<td></td>
<td></td>
<td>Reference missing (Alex Atting, United Kingdom (of Great Britain and Northern Ireland))</td>
<td>Accepted. To be explained.</td>
</tr>
<tr>
<td>6308</td>
<td>44</td>
<td>42</td>
<td>45</td>
<td>20</td>
<td>We need more detail here as to how the Manizales case study is a case study relevant specifically regarding the 1.5ºC goal. At the moment it is just a grouping by captions. (Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland))</td>
<td>Accepted. To be made explicit in the context of 1.5ºC goal.</td>
</tr>
<tr>
<td>3077</td>
<td>45</td>
<td>9</td>
<td>45</td>
<td>10</td>
<td>Could grammar in main sentence: “Planning remains mindful of steep gradients”? What does this mean? (Chloé Fabre-Ballela, Canada)</td>
<td>Accepted. To be explained.</td>
</tr>
<tr>
<td>1377</td>
<td>45</td>
<td>23</td>
<td></td>
<td></td>
<td>Implementing SD and the SDGs could be found a bit redundant for a title, would not “Implementing the SDGs” be sufficient? (Roger Cremades, Germany)</td>
<td>Noted, SD and SDGs are now discussed in Ch. 5</td>
</tr>
<tr>
<td>15044</td>
<td>45</td>
<td>23</td>
<td></td>
<td></td>
<td>While the SDG may be relevant to conceptualizing “sustainable development” within the discussion of global warming of 1.5 degrees, the SDGs are not the focus of this exercise. Authors should stick to the mandate given to them from the Panel and not incorporate other goals which broaden the analysis of this report beyond the mandate of the IPCC and issues specifically relevant to global warming of 1.5 degrees. (Farhan Akhtar, United States of America)</td>
<td>Noted, SD and SDGs are now discussed in Ch. 5</td>
</tr>
<tr>
<td>10599</td>
<td>45</td>
<td>23</td>
<td></td>
<td></td>
<td>You cannot “implement” SD or SDGs. You can implement policies to steer development towards a more sustainable path, which in turn can “achieve” some of the goals that are not well defined yet, in terms of targets and indicators. (José António Pimentel de Oliveira, Brazil)</td>
<td>Noted, SD and SDGs are now discussed in Ch. 5</td>
</tr>
<tr>
<td>17236</td>
<td>45</td>
<td>23</td>
<td>45</td>
<td>23</td>
<td>Heading is unclear (Himangana Gupta, India)</td>
<td>Noted, SD and SDGs are now discussed in Ch. 5</td>
</tr>
<tr>
<td>18763</td>
<td>45</td>
<td>23</td>
<td>46</td>
<td>34</td>
<td>Section 4.4.2 should highlight to a greater extent the potential synergies between achievement of climate action and the SDGs. For example, NDGs show a high potential level of convergence with SDG targets. See for example, Norrloph, E., H. Bru, S. Lima, M. Boure, and R. Sørensen, 2016. “Examining the Alignment Between the Intended Nationally Determined Contributions and Sustainable Development Goals.” Working Paper. Washington, DC: Resources Institute. (David Wiselink, United States of America)</td>
<td>Noted, SD and SDGs are now discussed in Ch. 5</td>
</tr>
<tr>
<td>18827</td>
<td>45</td>
<td>23</td>
<td>46</td>
<td>34</td>
<td>Section 4.4.2 should highlight to a greater extent the potential synergies between achievement of climate action and the SDGs. For example, NDGs show a high potential level of convergence with SDG targets. See for example, Norrloph, E., H. Bru, S. Lima, M. Boure, and R. Sørensen, 2016. “Examining the Alignment Between the Intended Nationally Determined Contributions and Sustainable Development Goals.” Working Paper. Washington, DC: Resources Institute. (David Wiselink, United States of America)</td>
<td>Noted, SD and SDGs are now discussed in Ch. 5</td>
</tr>
<tr>
<td>1215</td>
<td>45</td>
<td>23</td>
<td>47</td>
<td>35</td>
<td>We discuss implementing SD and the SDGs at length in Ch. 5. We would advise that you remove this section 4.4.2 entirely, along with boxes 4.3 and 4.4. We could take up part of your Brief case study in the context of discussing case studies of emerging climate-resilient development pathways (Brazilia part of our mix). (Peter Tachell, Australia)</td>
<td>Accepted. SD and SDGs are now discussed in Ch. 5</td>
</tr>
<tr>
<td>15042</td>
<td>45</td>
<td>25</td>
<td>45</td>
<td>25</td>
<td>The section did not emerge from the Paris Agreement. There is no need to mention the Paris Agreement in this sentence, as the focus should be specifically on the transition to 1.5°C G W. (Farhan Akhtar, United States of America)</td>
<td>Noted, SD and SDGs are now discussed in Ch. 5</td>
</tr>
<tr>
<td>6983</td>
<td>45</td>
<td>25</td>
<td>45</td>
<td>26</td>
<td>This section statement seems correct, but consider whether it contains a bias by mentioning only part of the question related to the 1.5ºC challenge. In particular it seems to imply a trade-off between the achievement of the SDGs and the achievement of staying below the 1.5ºC target but it does not consider or mentions a much greater trade-off between the achievement of the SDG and going beyond the 1.5ºC target. In fact, going beyond the 1.5-2.0°C target may render many SDG unfeasible. (J-David Tabaks, Spain)</td>
<td>Noted, SD and SDGs are now discussed in Ch. 5</td>
</tr>
<tr>
<td>17683</td>
<td>45</td>
<td>25</td>
<td>45</td>
<td>25</td>
<td>A good place to address the concerns raised above might be section 4.4.2. A redundant common way to think about equity is that a just equitable and no valid mitigation policy must, at the very least, not compromise the sustainable development goals. Section 4.4.2 would then be a good place to discuss the nature of equity and the just transition to a decarbonised economy. Relevant issues concern the fair distribution of the remaining budget of greenhouse gas emissions. For example, Caney ‘Climate Change and the Duties of the Advantage’, Critical Review of International Social and Political Philosophy, vol.13 no.1 (2010), 203-228; Simon Caney ‘Cosmopolitan Justice, Responsibility, and Global Climate Change’, Leiden Journal of International Law, vol.18 no.4 (2005), 747-775; (Simon Caney, United Kingdom (of Great Britain and Northern Ireland))</td>
<td>Noted, this is now discussed in Ch. 5</td>
</tr>
<tr>
<td>15043</td>
<td>45</td>
<td>28</td>
<td>45</td>
<td>26</td>
<td>The Paris Agreement does not have a direct linkage to SDG13. Their outcomes are the related, but they are not linked in any way. (Farhan Akhtar, United States of America)</td>
<td>Accepted</td>
</tr>
<tr>
<td>15507</td>
<td>45</td>
<td>31</td>
<td>45</td>
<td>31</td>
<td>Energy decentralization and digitalization hold an important promise in this direction, addressing both energy access deficiencies and energy security and generation problems. (Yana POPOVSKOVA, France)</td>
<td>Accepted, energy decentralization, electrification, and microgrid are discussed as options under 4.3.</td>
</tr>
<tr>
<td>7367</td>
<td>45</td>
<td>32</td>
<td>45</td>
<td>32</td>
<td>‘Do not use future, but present: climate change is now.’ (Knut Kjøl, Austria)</td>
<td>Rejected, to be discussed in Ch. 4, text has been moved to Ch. 5</td>
</tr>
<tr>
<td>11162</td>
<td>45</td>
<td>36</td>
<td>45</td>
<td>42</td>
<td>Some challenges associated with achieving the SDGs and 1.5 deg pathways would also apply for 2.5 deg pathways, but as written this section implies that the 1.5 deg would be particularly challenging for implementing the SDGs. It would be useful to highlight that 2.5 pathways would also entail similar challenges. The impacts of climate change and their effects on attainment of the SDGs should also be mentioned here, along with potential co-benefits for the SDGs from a transition to a 1.5 pathway (e.g. jobs, health) (Michael Schwab, Netherlands)</td>
<td>Noted, SD and SDGs are now discussed in Ch. 5</td>
</tr>
</tbody>
</table>
The paragraph needs some re-writing as it implies that pursuing sustainable development could undermine decarbonization when the intent (I assume) is to point out that sustainable development means doing things in a very different way in order to ensure that the goals of decent work, industrialization, infrastructure provision etc. also support the 1.5 degrees goal. After all, if they don’t then they’re not sustainable. In addition, I do not understand the logic behind the statement that leaving no-one behind might challenge the efficacy of market-based instruments in promoting innovation. I cannot understand why implementing any kind of basic social ‘safety net’ to lift people out of abject poverty would undermine innovation. [Stewart Lockie, Australia]

Accepted, this is now discussed in Ch. 5

The EMF (2015) summarises indicators that can be used to measure an economy’s current performance and to inform sustainable policy: Energy productivity - GDP per kilogram domestic material consumption, Climate change and its interactions with other policy domains, Emission intensities – Energy greenhouse gas emissions per GDP output.

Noted, this section is now discussed in Ch. 5

Strategically, the most important role of the circular economy is to reduce the adverse interactions between the economy, the environment and the public resources of the world, ensuring that the well-being of future generations is linked to sustainability. Among the factors supporting a shift to a circular economy is climate change. Production and consumption patterns need to be sustainable in the long term in order to address greenhouse gas emissions, which have to be globally reduced to zero by 2050 to respect the 2°C global warming threshold (UNFCCC, 2015). Current global consumption patterns present to be 50% over sustainable levels (Global Footprint Network, 2015). Since in developed countries, 55-65% of greenhouse gas emissions are related to the extraction, transport and processing of raw materials (OSCD, 2012), circularity, through a reduction in the energy needed to extract, transport and process these materials, reduces greenhouse gas emissions. [Geraldine Ann Cusack, Ireland]

While it can be argued that solutions driven by communities are more likely to be locally appropriate, the evidence suggests that inequality exists at all levels—from households to global level. So community-driven solutions still need to be examined in relation to the factors of feasibility. This is particularly the case around gender, as some solutions, if determined by community elites, may not be appropriate or may undermine the achievement of other SDGs. A similar challenge could be expected for other segments of community population who may be marginalized or have less power in decision-making (e.g., youth, minorities, etc.). [Tonya Rees, United States of America]

Noted, SD and SDGs are now discussed in Ch. 5

It is stated that “there is no simple answer”. I do not know what case study literature is being referred to here as there are no citations, however one very simple way to increase the uptake of renewable energy is to make it cheaper. This is done by improving the efficiency of the technology and by reducing the cost of production. [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)]

Noted, this is now discussed in Ch. 5

It is certainly not quite as bad as the status quo. [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)]

It is stated that “there is no simple answer”. I do not know what case study literature is being referred to here as there are no citations, however one very simple way to increase the uptake of renewable energy is to make it cheaper. This is done by improving the efficiency of the technology and by reducing the cost of production. [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)]

Noted, this is now discussed in Ch. 5

It stated that “there is no simple answer”. I do not know what case study literature is being referred to here as there are no citations, however one very simple way to increase the uptake of renewable energy is to make it cheaper. This is done by improving the efficiency of the technology and by reducing the cost of production. [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)]

Noted, this is now discussed in Ch. 5

It is true that the national question is complex and cannot be resolved simply by introducing new measures for the sake of it. However, the evidence suggests that inequality exists at all levels—from households to global level. So community-driven solutions still need to be examined in relation to the factors of feasibility. This is particularly the case around gender, as some solutions, if determined by community elites, may not be appropriate or may undermine the achievement of other SDGs. A similar challenge would exist for other segments of community population who may be marginalized or have less power in decision-making (e.g., youth, minorities, etc.). [Tonya Rees, United States of America]

Noted, this is now discussed in Ch. 5


Wang Xiaojun?Zhang Jianyun?Shamsuddin Shahid?strictest water resource management (SWRM) , it including "Water use, Water pollution redlines" for water management under changing environment, also including demand control and quota management ways, it is simply not quite as bad as the status quo. [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)]

Noted, this is now discussed in Ch. 5
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>2905</td>
<td>46</td>
<td>44</td>
<td>46</td>
<td>44</td>
<td>case study should add chinese ways for climate change adaptation. “A critical water resource management (SRWMI),” 4 including “Water use, Water pollution, Water power; pollution法令,” for water management under changing environment, also including demand control and quota management ways, spin the literature. The new concept of water resources management in China ensuring water security in changing environment. Demand control and quota management strategy for sustainable water use in China, they are ready good ways for climate adaptation.</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>2547</td>
<td>46</td>
<td>43</td>
<td>46</td>
<td>43</td>
<td>case study should add chinese ways for climate change adaptation. “A critical water resource management (SRWMI),” 4 including “Water use, Water pollution, Water power; pollution法令,” for water management under changing environment, also including demand control and quota management ways, spin the literature. The new concept of water resources management in China ensuring water security in changing environment. Demand control and quota management strategy for sustainable water use in China, they are ready good ways for climate adaptation.</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>1908</td>
<td>46</td>
<td>44</td>
<td>46</td>
<td>44</td>
<td>Box 4.3.1 was wondering why you did not select the Illinois Industrial CCS project as a case study. This is a BECCS on a bioethanol plant at commercial scale (1 MTCO2e). I found no reference to BECCS or a BECCS facility in IPCC. More info here: <a href="https://www.carbonbrief.org-analysis-negative-emissions-tested-worlds-first-major-beccs-facility">https://www.carbonbrief.org-analysis-negative-emissions-tested-worlds-first-major-beccs-facility</a></td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>4305</td>
<td>46</td>
<td>43</td>
<td>46</td>
<td>43</td>
<td>Suggestion to add case study for bio-ethanol production with carbon storage as a current working example of BECCS. More info here:</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>1476</td>
<td>46</td>
<td>43</td>
<td>46</td>
<td>43</td>
<td>This case study overstates the value of carbon capture in Brazil as a significant cost mitigation strategy. There remain insufficient greenhouse gas LCA data to be sure that the C benefits will be realized. For instance, NOx emissions from sugar cane are poorly quantified and, as with other biofuels, can offset a significant amount of the net CO2 savings achieved through fuel substitution (e.g. Crutzen et al. 2008) and Reay (2011) (David Reay, United Kingdom of Great Britain and Northern Ireland)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>14295</td>
<td>46</td>
<td>41</td>
<td>46</td>
<td>41</td>
<td>Further should probably be longer (Jason Golden, Canada)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>21187</td>
<td>46</td>
<td>43</td>
<td>46</td>
<td>43</td>
<td>note that adding biofuel crop sugarcane in Brazil is particularly efficat at using sunlight to fix CO2, and therefore that LUC and carbon debt, while first, of in stead of “first, is” (Christopher Bataille, Canada)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>21188</td>
<td>46</td>
<td>43</td>
<td>46</td>
<td>43</td>
<td>note that these positive results are due to strong land use policy, including forest code, use of agroecological zoning and prohibition of sugarcane bioethanol production in Amazon (David Cooper, Canada)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>3620</td>
<td>46</td>
<td>42</td>
<td>46</td>
<td>42</td>
<td>urge the report authors to be more focused in evaluation of Seeyachir's critique of carbon saving potential of ethanol. If we fail to have an impact on policymakers it is not enough to say politely that other studies don't confirm Seeyachir's findings. I encourage some delving into the different assumptions used by different authors. If there is no potential of biofuel to contribute to climate objectives then resources should be devoted elsewhere. If there is potential for biofuels then say that. As an example, work criticizing energy balance of com ethanol (Pimental and Patzek, 2005) is now generally understood to have assumptions of embodied energy in machinery and fertilizers that are orders of magnitude higher than other LCA (Marteil Cooper, Canada)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>18469</td>
<td>46</td>
<td>46</td>
<td>46</td>
<td>46</td>
<td>Avoid “Searchinger and Hertlum” grey shaded Mendley field with “2015” (Wilh Michoufala Oka, France)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>10740</td>
<td>46</td>
<td>46</td>
<td>46</td>
<td>46</td>
<td>Reference to “2015” and the figure number in Mendley instead (Wilh Michoufala Oka, France)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>17743</td>
<td>46</td>
<td>31</td>
<td>46</td>
<td>31</td>
<td>Reference missing (Mike Alcock-Robinson, United Kingdom of Great Britain and Northern Ireland)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>3621</td>
<td>46</td>
<td>47</td>
<td>46</td>
<td>47</td>
<td>Very interesting box but it does not answer the key question that the section introduces. eg. Are SDG goals and 1.5 warming compatible? To answer that we need to know there was high level of “in situ” scenario. If so then given SDG11 and SDG6 games the case shows that SDG goals and 1.5 goal are compatible (the community cohesion / social capital difference – while important – is a red herring in the terms of the purpose of the section (Stewart Fast, Canada)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>14386</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>The bibliographic entry for IPCC 2014 should have the title as just “Climate Change 2014: Impacts, Adaptation, and Vulnerability” if intending to refer to both Parts A and B of the AR5 WGII report. Right now it refers to Part B (Wilfran Moufouma Okia, France)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>3078</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>Int. of this is my thanks to [Christopher Bataille, Canada]</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>767</td>
<td>47</td>
<td>35</td>
<td>47</td>
<td>35</td>
<td>This paragraph is after Box 4.3, yet refers to “The next case study” Perhaps it takings before Box 4.3 and refer to Box 4.3 (Moshe Kinn, United Kingdom of Great Britain and Northern Ireland)</td>
<td>Noted, this section is now discussed in Ch. 5</td>
</tr>
<tr>
<td>19740</td>
<td>47</td>
<td>38</td>
<td>47</td>
<td>38</td>
<td>Section on multilateral governance - see the work of IED on decentralised climate finance and decentralised adaptation planning. [Tara Shire, Ireland]</td>
<td>Partly accepted decentralised adaptation planning discussed in the section, finance discussed in another section</td>
</tr>
<tr>
<td>15690</td>
<td>47</td>
<td>38</td>
<td>47</td>
<td>38</td>
<td>Governance discussion was not included in the SR15 approved outline. IPCC is not the adequate forum to discuss governance, with it not in its mandate. The whole 4.3 section should be deleted (Erena Darnis, Philippines)</td>
<td>Rejected, governance is key to strengthening the implementation</td>
</tr>
<tr>
<td>15442</td>
<td>47</td>
<td>38</td>
<td>47</td>
<td>38</td>
<td>Governance discussion was not included in the SR15 approved outline. IPCC is not the adequate forum to discuss governance, with it not in its mandate. The whole 4.3 section should be deleted (Erena Darnis, Philippines)</td>
<td>Rejected, governance is key to strengthening the implementation</td>
</tr>
<tr>
<td>10221</td>
<td>47</td>
<td>38</td>
<td>47</td>
<td>38</td>
<td>For me this section was too all encompassing and too long; covering material better suited to AR5, could you focus on the part directly relevant to SR15? (Piers Forster, United Kingdom of Great Britain and Northern Ireland)</td>
<td>Rejected, almost impossible to discuss governance only related to 1.5. It needs to be placed in a water context</td>
</tr>
</tbody>
</table>
This is an important topic (multi-governance), but it is not clear what "extra" efforts in terms of governance would be needed to reach the 1.5°C goals. All this line illustrates a more general point. This sentence and others in the chapter implicitly "assume" the feasibility of 1.5°C. Chapter 1 says we don't expect the need for any new initiatives within the current structures, but that's not clear.

Interaction between actors needs to at least offer a physical arena that communities are comfortable with. [Morien Rees, Norway] Accepted: physical arena already added in the previous paragraph.

Also international networks, such as the Global Island Partnership (GLISPA), are examples of horizontal collaboration, and important in the climate change mitigation and adaptation context. [Elvira Poloczanska, Germany] Accepted.

As the line refer to 'Capacity for Change' and basically 'change' does not say much about its intensity, reach or speed, consider to include the notion of 'transformative capacities' (in plural). [J. David Tabara, Spain] Accepted.

The governance of the low-carbon transition is developing in a context of multi-party transnational framework (EU Member States - EU institutions - UN Country groups/Institutions - private and public actors) and surrounded by multiple policy (financial, social, anti-globalization and technological) challenges. The interacting actor and problem settings might have an adverse impact on the democratic governance of the process, and the author of this comment currently examines mechanisms to stress-test the energy governance of the transition against potential democratic deficit dynamics. The impact of the EU as a transnational governance actor on its compounding Member States' national energy governance (Europeanisation), but also on international climate politics (policy diffusion) would be an important case study to be included in the negotiation and implementation of the agreements. Further, it is the complex context of multi-party/multi-level planning exercise and in the absence of solid enforcement mechanisms, the paradigm of compliance becomes key. How can a transnational energy governance scheme be not only democratically but also enforceable and what is the role of the institutional design? [Yana POPROSTOVA, France] Noted.

The governance of the low-carbon transition is developing in a context of multi-party transnational framework (EU Member States - EU institutions - UN Country groups/Institutions - private and public actors) and surrounded by multiple policy (financial, social, anti-globalization and technological) challenges. The interacting actor and problem settings might have an adverse impact on the democratic governance of the process, and the author of this comment currently examines mechanisms to stress-test the energy governance of the transition against potential democratic deficit dynamics. The impact of the EU as a transnational governance actor on its compounding Member States' national energy governance (Europeanisation), but also on international climate politics (policy diffusion) would be an important case study to be included in the negotiation and implementation of the agreements. Further, it is the complex context of multi-party/multi-level planning exercise and in the absence of solid enforcement mechanisms, the paradigm of compliance becomes key. How can a transnational energy governance scheme be not only democratically but also enforceable and what is the role of the institutional design? [Yana POPROSTOVA, France] Noted.

Museums are spaces that can accommodate communication of both approaches, locally for the bottom up approach while a global infrastructure that allows for communication for the top down national and supranational one. [Morien Rees, Norway] Noted.

Cross-stakeholder interaction can backfire: it can paralyze a political system (a) if not all parties share the same environmental preferences and interests and (b) if it moves at stake than environmental interests alone. Success is not just a question of coordination; coordination is possible only where interests do not clash. [Marcel Wissenburg, Netherlands] Rejected; almost impossible to discuss governance only related to 1.5. It needs to be placed in a broader context.

I think that what the author had in mind is that our ability to address climate change is limited by the fact that environmental interests are not always strong enough to overcome the other, societal forces. Some of these forces include economic, geopolitical, cultural, religious, and other forces, which can have a significant impact on decision-making and policy formulation. The ability of citizens (as people) to shape the political landscape and influence governance is crucial to addressing climate change effectively. [Jose Antonio Puppim de Oliveira, Brazil] Accepted with no change. Citizens (as people) are mentioned several time in the text.

Do Not Quote, Cite, or Distribute Page 115 of 159

IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4

Page 115 of 159
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Accepted/Rejected</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>11468</td>
<td>49</td>
<td>1</td>
<td>49</td>
<td>1</td>
<td>I would use the term &quot;international governance&quot; to avoid any suggestion this section will challenge the sovereignty of nation states. [Stewert Locke, Australia]</td>
<td>Accepted</td>
<td></td>
</tr>
<tr>
<td>3083</td>
<td>49</td>
<td>1</td>
<td>50</td>
<td>25</td>
<td>4.4.3.1.1 is good, but let us see other voices of the UNFCCC negotiations to make sure if is how they remember it [Christopher Batella, Canada]</td>
<td>Accepted</td>
<td></td>
</tr>
<tr>
<td>6214</td>
<td>49</td>
<td>1</td>
<td>50</td>
<td>25</td>
<td>The whole section on global governance could be much better organised and presented, Most generally, it seems to me it could draw on the relevant ch of AR5 more directly, which has a much fuller discussion, while that has changed in this literature (not an awful lot, although some significant work on coordination across different sites of climate governance, as in the pieces by Batella et al and by Hale and Roger mentioned above, and then be much more specific about what thinking about 1.5C means the talk about this literature. The discussion of 1.5C in relation mostly to the Paris Agreement is rather unclear, I wasn’t really sure what the point. I think it could be reasonable to claim that the IPA design enables much more regular, iterative, lightening of NOCs and much more flexible, &quot;experimental&quot; forms of climate governance which are consistent with the needs of governing for a rapid transition, perhaps that is what is intended on p.15, lines 6-17, but it is not very clear [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accepted</td>
<td></td>
</tr>
<tr>
<td>1535</td>
<td>49</td>
<td>1</td>
<td>50</td>
<td>25</td>
<td>You might also want to consider the importance of regional cooperation and development in the context of global governance, and creating a bridge to local governance. For example we showed in <a href="http://bit.do/zyAI1">http://bit.do/zyAI1</a> April 15, 2018, the potential implementation of Paris instruments on finance, capacity building, and south-south cooperation could make the different for solar thermal electricity production to achieve a cost-competitive position vis-à-vis fossil generation within the timeframe required for a 1.2°C target. In <a href="https://bit.do/zyAI1">https://bit.do/zyAI1</a> April 12, 2018, we looked at the regional governance requirements for infrastructure sitting, which would enable Europe to achieve a complete decarbonisation of its power system, and that major changes would be required. Others in doi:10.1038/ncliimate3338 look at how international cooperation on wind power deployment could enable substantially higher penetration rates, needed for complete decarbonisation, while retaining system reliability. DOI: 10.1038/NCLIMATE2376 did the same with respect to solar thermal power. On maybe some of these ideas better fit section 4.4.3.1 [Anthony Patt, Switzerland]</td>
<td>Accepted</td>
<td></td>
</tr>
<tr>
<td>20428</td>
<td>49</td>
<td>2</td>
<td>49</td>
<td>7</td>
<td>The first paragraph should also note that, other international agreements also have a bearing on climate change for example multilateral trade agreements or bilateral agreements related to agriculture, energy or transport. [Jeremy Webb, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accepted multilateral trade agreements or bilateral agreements added</td>
<td></td>
</tr>
<tr>
<td>17745</td>
<td>49</td>
<td>4</td>
<td>49</td>
<td>7</td>
<td>Reference missing (Aluoo-Baosing, United Kingdom (of Great Britain and Northern Ireland)</td>
<td>Accepted reference added</td>
<td></td>
</tr>
<tr>
<td>20429</td>
<td>49</td>
<td>5</td>
<td>49</td>
<td>7</td>
<td>Anthropogenic climate change is governed under the UNFCCC as the global level - the UNFCCC defines climate change as &quot;a change of climate which is attributed directly or indirectly to human activity and which is in addition to natural climate variability observed over comparable time periods.&quot; Any natural climate change, or natural variation, is not governed by the UNFCCC. [Jeremy Webb, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accepted reference added</td>
<td></td>
</tr>
<tr>
<td>16441</td>
<td>49</td>
<td>9</td>
<td>49</td>
<td>11</td>
<td>Another reason seems to be that if fitting targets with penalties are going to be imposed, nations will set targets that are so limited that there is virtually no chance of having a penalty imposed (consider Australia in the Kyoto process, the goal for which was to only increase emissions by 1%; I think it was 7-8% not even a reduction goal). With such limited targets, the commitments were nowhere near enough to accomplish much at all. With the Copenhagen and Paris approach of voluntary targets and the only penalty being public exposure by the failure to meet the goal, the targets could be aspirational and then groups promoting the effort such as environmental NGOs and manufacturers of renewable technologies could go all out and show that targets were achievable and, in many cases, not as ambitious as could actually be achieved, and so there could be a catching up of targets to do even better-and with all countries pulling together and trying to out target each other with no fear of penalties, the targets could be much closer to what is needed, even if it did not get close enough to keep the global average temperature increase to less than 1.5°C before it increases thereafter (and the need to decrease to below 1.5°C is as important as keeping the peak as low as possible). While not an expert in this area, what I have heard and read suggests the reason given above was much more important than the reason given on line 11. [Michael MacCracken, United States of America]</td>
<td>Accepted</td>
<td></td>
</tr>
<tr>
<td>11163</td>
<td>49</td>
<td>9</td>
<td>49</td>
<td>11</td>
<td>While binding targets are seen by some as the strongest and most effective form of global climate governance, the failure to negotiate binding targets in the Paris Agreement (Patt 2017) is because a new temperature target does not only entail emission reduction- this is an additional interpretation of why binding targets were not negotiated in Paris. There were political reasons for adopting a bottom-up system with nationally determined contributions, following the lack of success of binding targets under the Kyoto Protocol. Similar statements like this should be avoided [Michael Schaeffer, Netherlands]</td>
<td>Accepted</td>
<td>Changed wording of this sentence.</td>
</tr>
<tr>
<td>20430</td>
<td>49</td>
<td>9</td>
<td>49</td>
<td>19</td>
<td>The IPCC might want to refer to climate change as a problem of &quot;collective action&quot; as it did in the 5th Assessment Report in the Synthesis report (page 102). It can then be said that the collective action models invoke cooperative as well as non state actors. [Jeremy Webb, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accepted non state actors mentioned</td>
<td></td>
</tr>
<tr>
<td>4890</td>
<td>49</td>
<td>10</td>
<td>49</td>
<td>10</td>
<td>Failure to negotiate is far from impartial (and for many a fairly obvious) characterization of the Paris Agreement; it supports themyes that the IPCC and its authors are politically naive and self-righteous. The absence of (or words to that effect) is more neutral and more appropriate [Marc Janssen, Netherlands]</td>
<td>Accepted text changed</td>
<td></td>
</tr>
<tr>
<td>768</td>
<td>49</td>
<td>13</td>
<td>49</td>
<td>13</td>
<td>It states &quot;low probability of enable a transition&quot;. Perhaps it should read &quot;of enabling&quot; or &quot;to enable&quot; [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]</td>
<td>Accepted editorial, will change</td>
<td></td>
</tr>
<tr>
<td>3090</td>
<td>49</td>
<td>13</td>
<td>49</td>
<td>13</td>
<td>incorrect which have a low probability of enabling a transition to a 1.5°C world [Christopher Batella, Canada]</td>
<td>Accepted editorial, changed</td>
<td></td>
</tr>
<tr>
<td>14048</td>
<td>49</td>
<td>13</td>
<td>49</td>
<td>13</td>
<td>In incorrect [Elke Pötschke, Germany]</td>
<td>Accepted editorial, will change</td>
<td></td>
</tr>
<tr>
<td>20258</td>
<td>49</td>
<td>18</td>
<td>49</td>
<td>19</td>
<td>Museums offer an unique global infrastructure to communicate international governance. [Wenon Resse, Norway]</td>
<td>Accepted editorial, will change</td>
<td></td>
</tr>
</tbody>
</table>

2015: Building Productive Links between the UNFCCC and the Broader Global Climate Governance Landscape. Global Environmental Politics 15:1–10. Some of these are mentioned in the next paragraph but it ought to be integrated into how global governance of climate is stated upfront. [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)]

The first paragraph should also note that, other international agreements also have a bearing on climate change for example multilateral trade agreements or bilateral agreements related to agriculture, energy or transport. [Jeremy Webb, United Kingdom (of Great Britain and Northern Ireland)]

Reference missing (Aluoo-Baosing, United Kingdom (of Great Britain and Northern Ireland)|
The suggestion that "emissions can be allocated by country" is the type of top-down approach that was unsuccessful in Kyoto--or at least ended up with a Protocol that neither included all nations nor really accomplished much more than to slightly slow the increase in emissions. Getting agreement on the rules of the allocation scheme on a global basis would lead to interminable debate, delaying action that is urgently needed. The first part of this sentence was well written, meaning that with nations committed to emissions reductions, carbon markets can be established--I would note in this regard, however, that the notion of making the markets international was a reason that environmental NGOs objected to the Kyoto Protocol, complaining that the US (and other rich countries) would then simply buy up the low cost mitigation in other nations instead of making a serious effort to limit their own emissions. I think this whole sentence might best be dropped as a significant over-simplification of considerations among international carbon markets, etc. [Michael MacCracken, United States of America]

Accepted, sentence has been deleted.

The same here as in comment 44 above. Everyone should agree that there is a need to reduce our consumption of energy. The way to do that is to re-engineer technology to be more efficient, and use alternative energy sources than those that produce GHGs. Therefore engineers need to be involved in providing input as to how climate governance needs to focus on ways to help them achieve their objectives. [Misha Kinn, Kingdom of Great Britain and Northern Ireland]

Rejected, not relevant here.

6123 49 40 49 51
what is meant by the "failure of the KP"? This is often stated but it has mostly a rhetorical rather than analytical quality--it is the case here. If it is that the commitments under the KP were not met, this is largely not true. If it is the case that the KP's commitments were inadequate to the task, then this is not a failure of the KP but of the system and actors that produced it. [Matthew Paterson, Kingdom of Great Britain and Northern Ireland]

Accepted Test changed.

3981 49 42 49 42
was it the absence of rules, or the inability to agree on rules? [Christopher Bataille, Canada]

Accepted text changed as proposed.

17315 49 44 49 45
The sentence "A burden sharing approach led to an adversarial game among nations to decide who shall be allocated 'how much' of the remainder of..." was it the absence of rules, or the inability to agree on rules? [Christopher Bataille, Canada]

Accepted text deleted.

13142 49 48 49 48
The local point of the Kyoto Protocol to Article 17, which set out the establishment of the Emission Trading System (ETS) to meet quantified emissions limitation and reduction commitments; however, so far ETS is mainly restricted to local or regional level, and World Bank Group (2014) described that accelerated ETIs increase the complexity across jurisdiction. Connected ETIs provide platform for political commitment and enable the alignment of national strategies, cap structure and operational system, and trial linkage between existing ETIs to be key to provide insights on the establishment of ETS for countries without their own ETS and facilitate the expansion of the trial linkage into a global scale (Yu, 2016).


Accepted, we are dealing with governance issues not with ETS regimes.

4695 49 50 49 52
Add abbreviation "Paris Agreement (PA)" - see next page line 2 [Radim Tolasz, Czech Republic]

Rejected editorial, we have changed everywhere to Paris Agreement

18475 49 51 49 51
Remove "p." - put this page number in Mendeley instead [Wilfran Moufouma Okia, France]

Editorial

28 49 52 49 52

Rejected not relevant here. It is quoted in the NDC box

5009 50 2 50 3
Normally "under Art 7" should be expressed as "under Art 7 (Pro) [YUJU NINDZOU, Japan]

Accepted editorial.

770 50 2 50 3
The words are Art 7, "Pro" and "Art 7 (Pro)", the wording is Art 7 1-7, 2-7. However all other uses it 2-7., Art 6 and similarly PA is written in full Paris Agreement, page 54. There is a need for consistency. [Misha Kinn, Kingdom of Great Britain and Northern Ireland]

Accepted Editorial, changed as requested

5611 50 3 50 3
Joint credit mechanism (JCM) should be "Joint Crediting Mechanism (JCM) [YUJU NINDZOU, Japan]

Noted; editorial.

9612 50 3 50 4
The JCM is not based on Art 6 4.7, but instead on Articles 6.2 [YUJU NINDZOU, Japan]

Noted; the mechanism in introduced in 6.4 and 6.7

19743 50 6 50 11
Include a reference to human rights and lex standards. [Tara Shins, Ireland]

Rejected, not relevant in this paragraph

16443 50 8 50 8
It seems to me that "evolution of the finance and monetary system" is really too mild a description of what is needed in this area. Basically, much greater financial resources are needed if the transition is to occur--and because many aspects of the transition will pay off in the long term (and a great bit even in the near term), the increase in resources could involve much higher levels of green bonds to the level of effort made in the Marshall Plan after WWII, which was accomplished by capitalizing development banks sufficiently that enough could be done with financial partnerships that the private banks simply could no longer afford to stay out of the redevelopment effort, and the European economy took off in a way that was way beyond traditional ways of thinking. Such an incentive to transition is again needed where money invested in banks can be leveraged to do much more than can be done by just counting country contributions without leverage. [Michael MacCracken, United States of America]

Noted, not relevant for the section on governance but added cross-reference to section 4.4.8 which deals with the topic.

3083 50 9 50 9
who is "they"? [Christopher Bataille, Canada]

Accepted text deleted.

14100 50 17 50 17
not with bilateral games (which is how global governance works) -- see Robert Axelrod 1984 book The Evolution of Cooperation re tit for tat start nice then reciprocate with some forgiveness at times [Rueda Harnack, Germany]

Accepted text changed.

2087 50 19 50 19
The reference to W. Harnack and K. K. Gun (2017) does not refer to coalitions of international actors as substitutes to states but on climate clubs (so not really as a complement to the UNFCCC as he just proposes trade sanctions to be included in the international climate agreement), so it should be moved to the next paragraphs (with Abbott, Biemans etc.). [Anjan Hagen, Germany]

Accepted, reference removed.

2085 50 19 50 22

Accepted, reference added.
The substantial increases in abatement cost to reach the 1.5 degrees target (p.3 1.30 - 36, p. 75: 23 - 28), will amplify the role abatement cost and their uncertainty play in climate negotiations. Moreover, abatement costs differ over regions and the heterogeneity will therefore determine cooperation in climate agreements, making financial transfers crucial. There is theoretical (Fuss and Pintoedagio 2013: Waskow 2009) and empirical evidence (Meys et al. 2017) that heterogeneity increases cooperation stability when abatement costs are available and decreases cooperation stability when they are not. Meys et al. (2017) study the effect of empirical uncertainties, calibrated to results from meta-studies, in abatement and damage cost on climate negotiations. They find that when transfers schemes are available heterogeneity in the regional distribution of abatement cost and damages can increase the stability of climate coalitions. From this one can infer that for a more stringent 1.5 degrees target it will become crucial to have compensation schemes in place for differences in abatement cost across agglomerations.

References:
12807 90 37 90 39 39
"Community-based adaptation is important, as you have noted, and there is literature documenting such experiences and evidence especially in developing countries, Adele et al. (2017). Enhancing Adaptation to Climate Change in Developing Countries through Community-Based Adaptation. Nairobi: ACTS Press. This literature also offers crucial contributions from developing countries which bear a disproportionate impact of climate change, as noted in the report, and across key developing countries. This comment also applies to section 4.4.3.3 lines 35-34 (evidence on adaptation to climate change at the community level) [Kennedy Mbeva, Australia]." Accepted, section has been revised and community-based adaptation is discussed more in-depth.

18478 50 41 50 41 "Move "Rutherford and Jaglin" into grey shaded Mendeky field with "2015" [William Moulouka Oka, France]." Accepted

7390 50 41 50 43 "It states "Box 1" I think it should be Box 4.12 [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]. Accepted, now Box 4.12

18479 50 48 50 48 "Move "MacGilvray" into grey shaded Mendeky field with "2015" [William Moulouka Oka, France]." Accepted

11045 50 51 51 27 "Box 4.5 is about all expected results, but not about actual results, which is a problem in the discourse on the EU Covenant of Mayors. If there are no measurable results yet, the box should be deleted [Oliver Gedde, Germany]. Accepted, text changed to include measured results

13074 51 1 51 26 "Box 4.5: The results indicated are expected. There is a monitoring report that shows that the results have been reached, maybe with an indepen- dence check. The cost of the reduction of CO2 seems very high, so I suggest to give space and consider this example only if there are confirmations that this has been a success story, not only a good project [Cassetti Stefano, Italy]. Accepted, text changed to include measured results

14282 51 13 51 13 "Cite or ODST? Please be consistent [Held to be with or without author] [Jason Donovan, Canada]. Accepted, text removed

14283 51 20 51 20 "20,375 is too many significant figures, implying too high a degree of accuracy [Jason Donovan, Canada]. Accepted, text changed

7112 51 21 51 24 "Could one then recommend education on ethics, environment and tolerance as a long-term mitigation measure? [Elna Mota, Sweden]. Rejected, not relevant for the box, should be mentioned in other section in 4.4 dealing with education

18480 51 32 51 32 "Put "e.g. outside grey shaded Mendeky field [William Moulouka Oka, France]. Accepted, "e.g." deleted

9289 51 33 51 33 "Cite: Romero-Lankao et al., 2016 [In Press] [Cynthia Rosenzweig, United States of America]." Accepted, section deleted

9289 31 39 51 39 "Cite: Rosenzweig et al., 2015 [Cynthia Rosenzweig, United States of America]." Accepted

1216 51 36 51 37 "Our analysis of climate-resilient development pathway case studies (at state and community scales) also shows that participation, social learning and iterative decision-making are important governance features of strategies that deliver mitigation, adaptation, and sustainable development in a fair and equitable manner. Link to section 5.7.4. [Peter Tschakert, Australia]." Accepted, link and text added

771 43 43 43 "What is a "zero-carbon alternative"? Is everything having a carbon pay-back period? If so, more all of energy production, i.e. the action of production does not produce GtCO2 should be scaled. Other use the terminology "carbon neutral" where the carbon footprint associated with energy production is balanced out by zero carbon generation [M智能型, United Kingdom (of Great Britain and Northern Ireland)]. Accepted, text deleted

19746 51 47 "This section on interactions and processes should refer to the value of a rights based approach and discuss access to information the right to participation and access to justice [Tan Sri Shire, Indonesia]." Accepted, text deleted

9090 51 47 "There is good information on multi-level approaches in Romero-Lankao et al., 2016 [In Press] and Graaflaet et al., 2018 [In Press] [Cynthia Rosenzweig, United States of America]." Accepted, but the reference not relevant here

11470 51 47 "It is unclear how multiple actors will come together because there are so many, nationally and sub-nationally, unique jurisdictions dictating how actors can come together. While the need for multi-level is self-evident (of course multiple layers of government must cooperate) the ways in which this will be operationalized will vary markedly between jurisdictions. Rather than trying to generalize about multi-level governance or establish categories, the section should simply try to identify where experiments appear to have worked and what has contributed to their success. Further, the statement that multilevel is governance is "particularly relevant in low income countries is a nonsense. It is relevant everywhere. [Stewart Lockie, Australia]." Partially Accepted, "particularly" eliminated

10256 51 47 51 47 "One also needs to mention well defined EU multi-level governance based on "smart specialization" (see: Implementing Smart Specialisation Strategies, 2015; available at: http://bit.ly/2sGjH7G) [Implementing Smart Specialisation Strategies]." Accepted, text deleted

20259 51 48 52 4 "Not for the first time in this report the question is posed of how the actors with various motivations and agendas will find a common meeting place to undertake action toward enacting the 1.5 transition. 50,000 museums are available in 202 countries. This infra structure is already in place and would thus offer the prospect of contributing to meeting the 1.5 goal despite the narrowing window of opportunity facing the world. [William Rees, Norway]." Rejected, not relevant for publication and not relevant for 1.5C

18481 51 51 52 52 "Move "Jordan and Huitema" into grey shaded Mendeky field with "2014" [William Moulouka Oka, France]. Accepted, "Jordan and Huitema" moved

9287 51 53 51 53 "Cite: MacGillivray et al. 2015 [In Press] [Cynthia Rosenzweig, United States of America]." Accepted, "MacGillivray" moved

18482 51 2 51 1 "Move "Rutherford" etc grey shaded Mendeky field with "2015" [William Moulouka Oka, France]. Accepted

4189 52 6 52 16 "Governments must also be cautious of raising ambition. While most certainly the climate change mission must be tackled with the utmost importance, if governments are to avoid increasing poverty and economic pressures which will result in a cascade of social impacts (including developed countries), they must be aware of the economic and social impacts that increasing ambition will have on residents. [Michelle Leslie, Canada]." Refer to Ch. 5. the comment is well formulated as higher ambition NDC leading to 1.5C could lead to additional costs

4098 52 9 52 9 "One also has to review "Box 4.1 MNCs" [Radiem Tokes, Czech Republic]." Accepted, reference "Box 4.1 NDCs" (Radiem Tokes, Czech Republic) Accepted, now Box 4.12

773 52 9 52 9 "It states: Box 1: I think I should be called K4 C1 [Michele Mora, United Kingdom (of Great Britain and Northern Ireland)]." Accepted, now Box 4.12

2763 52 12 52 16 "True. But at the same time, many developing countries have made much more progress in formalizing national policies, plans and strategies on responding to climate change - such as National Climate Policies (e.g. the Gambia, Namibia, Ghana, South Africa, Pakistan, etc) National CC Strategies and Action Plans (e.g. Afghanistan, Kenya, Rwanda, Bangladesh etc) etc. Low Emissions Climate Readiness Development Strategies in various countries (supported by UNDP, Strategic Programmes on Climate Resilience or PRPs). Supported by Climate Resilience Funds in various countries including Bolivia, Zambia, Philippines etc etc. Therefore national processes to develop integrated CC and development responses go way beyond the NDCs - which of course are more narrow and set out mitigation commitments only. This should be reflected in the text only. [Penney Associate, South Africa]." Accepted, suggested text added

18483 52 15 52 15 "Put "e.g. outside grey shaded Mendeky field [William Moulouka Oka, France]. Accepted, "e.g." moved

4763 52 15 52 15 "Remove comma after full stop in "e.g. "day", which becomes "e.g. day" [Valentino Piana, Italy]. Accepted, comma removed

4881 52 18 52 18 "This is one of the rare occasions where the reports admits there may be conflicts of interest inhibiting climate change policies; even so, the text still suggests (without proof or justification) that climate change policy is good and promoting other interests is bad. [Nicolae Wassenberg, Netherlands]." Accepted, text modified

4753 52 21 52 21 "Remove comma after full stop in "e.g. zeros", which becomes "e.g. zeros" [Valentino Piana, Italy]." Editorial
### Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
18747 | S2 | 25 | S2 | 27 | Refer to the right to participation and the need to address the gender dimension of climate change. See for example, Women’s Participation An Enabler of Climate Justice – First edition November 2015. Online at http://www.mnf.org.sg/downloads/2015/11/WFPG1_Women’sParticipation-An-Enabler-of-ClimatetJustice_2015.pdf [Tara Shine, Ireland] | Refer to Ch. 5 | Partially accepted. This section addresses the institutional challenges of informal settlement but damage we need specific relevant literature. | Rejected, not relevant for this section | Rejected, not relevant for this section. | Rejected - out of the scope of the chapter. | Rejected - out of the scope of the chapter.
19484 | S2 | 28 | S2 | 30 | Box 4.6 is not referenced in this section and is referenced in the next on page 54 line 21. Is this therefore the appropriate place for this box to sit? | Accepted | Accepted | Accepted | Accepted | Rejected. The section currently deals with the residual damage through the strengthening of Co-operative institutions and safety nets (4.4.4.4). To argue for specific institution for loss and damage we need specific relevant literature | Rejected. The section currently deals with the residual damage through the strengthening of Co-operative institutions and safety nets (4.4.4.4). To argue for specific institution for loss and damage we need specific relevant literature.
19485 | S2 | 32 | S2 | 34 | Move “Green” into grey shaded Mendeley field with “2016” [Wilfran Moufouma Okia, France] | Accepted: Editorial | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted | Accepted |Accepted
Comment

16444 55 1 55 7

These problems are exactly why Secretary of State General/George Marshall basically established and capitalized his own banks to initiate the Marshall Plan that started the recovery process in Europe after World War II. When Marshall's banks started making a good economic return, the commercial banks could no longer afford to sit on the sidelines and came in to amplify the effect. There is a group making this case to day in their analysis of the situation in Africa http://www.africagrowth.org.uk/ and I am one of those helping to encourage the effort and so is trying to encourage greater capitalization of banks selling to issue green bonds for efficiency investments and more as a starting point, using the leverage of capital that banks are allowed to ready build up the portfolio. So, the Marshall Plan is an example of how to overcome the problem discussed in this paragraph—what is needed is leaders who will step forward and make it happen (and the recovery of Europe after WWII probably required a greater effort than is needed now, given the significant advances in reducing the costs of renewables). [Michael MacCracken, United States of America]

Comment

18489 55 6 55 6

When "HSDV" intro grey shaded Mendley field with "2017" [Wilfran Moufouma Okia, France]

Comment

18490 55 9 55 9

When "Linnemerth-Bayer and Hochrainer-Stigler" intro grey shaded Mendley field with "2015" [Wilfran Moufouma Okia, France]

Comment

16445 55 17 55 22

The question of how international financial institutions and authorities to leverage their resources to the extent that banks are able to do. For the Marshall Plan example, the leveraging was particularly important, and given the seeming reluctance to put up funds (basically limited to a 1 to 1 basis), finding a way to get it going. For example, at the typical leveraging rate, a $400B capitalization would allow roughly $1T in loans to be made/bonds issued. That is the type of scaling up that is needed. [Michael/MacCracken, United States of America]

Comment

2754 55 17 55 22

It would be important to assess, here or elsewhere, the extent to which the required financial flows to LICs and other developing countries to achieve a 1.5 pathway are in place - both for capacity development and implementation - and the barriers and ways to overcome them. [Penny Urquhart, South Africa]

Response

Accepted. The word "traditional" is removed.

Response

Noted. The sentence is removed.

Response

Accepted. Paragraph is removed.

Response

Noted. The box is relevant to the strengthening of implementation institutions for 1.5c. Your suggestion for changing the title is incorporated.

Response

Accepted. The box will be revised and expanded.

Response

Noted.

Response

Rejected. This irrelevant to strengthening of institutions for 1.5c

Response

Accepted. The box is revised.

Response

Noted.

Response

Accepted. The word "traditional" is removed.

Response

Noted. Providing references are not citable according to the IPCC 1.5c report guidelines

Response

Accepted. Energy access reflected.

Response

Noted. Paragraph is removed

Response

Accepted. The box is removed.

Response

Noted.

Response

Accepted. The box is relevant to strengthening of implementation institutions for 1.5c. Your suggestion for changing the title is incorporated.

Response

Noted.

Response

Accepted. The box is removed.

Response

Accepted. Paragraph is removed.

Response

Accepted. Paragraph is removed.

Response

Accepted. The word "traditional" is removed.

Response

Accepted. The sentence is removed.

Response

Accepted. Paragraph is removed.

Response

Accepted. The box will be revised and expanded.

Response

Note. Provided references are not citable according to the IPCC 1.5c report guidelines

Response

Accepted. This relevant to strengthening of institutions for 1.5c

Response

Accepted. The word "traditional" is removed.

Response

Accepted. The box is revised.

Response

Accepted. This relevant to strengthening of institutions for 1.5c

Response

Noted.

Response

Rejected. This irrelevant to strengthening of institutions for 1.5c

Response

Accepted and reflected.

Response

Accepted and reflected.

Response

Accepted.

Response

Accepted. This relevant to strengthening of institutions for 1.5c

Response

Accepted.

Response

Accepted and reflected.

Response

Accepted and reflected.

Response

Accepted. The sentence is removed.

Response

Accepted. The word "traditional" is removed.

Response

Noted.

Response

Accepted. This relevant to strengthening of institutions for 1.5c

Response

Accepted.

Response

Noted.

Response

Accepted and reflected.

Response

Accepted. The box is removed.

Response

Noted.

Response

Accepted. The box is removed.

Response

Accepted. The word "traditional" is removed.
**IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4**

**1404**

**From Page:** 57

**To Page:** 57

**Comment:** Noted.

**Response:**

```
Noted.
```

**1404**

**From Page:** 2

**To Page:** 2

**Comment:** Noted.

**Response:**

```
Noted.
```

**1466**

**From Line:** 96

**To Line:** 97

**Comment:** Proposed that this box be developed. However, its introduction should be revised to note that indigenous communities have been interacting, using, remembering and sharing information about their environments for millennia (i.e. for centuries, and not only during the last 30 years). Local knowledge and research forecasting in Burkina Faso. Society and Natural Resources, 15: 409-427. [Philippe Routière, France]

**Response:**

```
Accepted. The box is reviewed.
```

**4933**

**From Line:** 19

**To Line:** 22

**Comment:** This section 4.4.5 is hard to read, contains a lot of generic material, and is quite long. Make more relevant? [Petra Tschakert, Australia] Taken into account. We revised and shortened the text, and extended the discussion on

**Response:**

```
Accepted. We consider reflecting the evidence based on the provided references.
```

**1926**

**From Line:** 19

**To Line:** 20

**Comment:** For centuries, indigenous communities have observed the behavior of flora, fauna, and climate phenomena on their crops, traditional land, and their communities. [Chrysalis Muyinya-Pinge, Canada]

**Response:**

```
Accepted. Paragraph reviewed.
```

**1926**

**From Line:** 24

**To Line:** 25

**Comment:** Indigenous traditional knowledge is not unique to the Mayan communities. Sharing of knowledge from generation to generation is common among all indigenous communities. [Chrysalis Muyinya-Pinge, Canada]

**Response:**

```
Accepted. The sentence suggesting scientific validation is revised.
```

**4936**

**From Line:** 36

**To Line:** 52

**Comment:** An example of how to use and share indigenous knowledge about changing environments in the Arctic is ECODE. Exchange for Local Observations and Knowledge of the Arctic (https://koalavicare.org/), hosted by the US National Snow and Ice Data Center. A statement that a diverse range of Arctic communities are already contributing to this exchange would be a useful addition to this box case study. [Marcy Rockman, United States of America]

**Response:**

```
Accepted. Revision of the box led to removal of arctic experience.
```

**1218**

**From Line:** 64

**To Line:** 67

**Comment:** This section 4.4.5 is hard to read, contains a lot of generic material, and is quite long. Make more relevant? [Petra Tschakert, Australia]

**Response:**

```
Taken into account. We reviewed and shortened the text, and extended the discussion on adaptation behaviour and made it more relevant for 1.5C.
```

**6218**

**From Line:** 62

**To Line:** 65

**Comment:** There is a very significant absence in this section on the literature which understands these aspects of climate change in terms of the notion of practice rather than that of behaviour. The work of Elizabeth Shove is central here but the literature is very broad. One of her pieces is mentioned on p55 but it ought to be represented more adequately. This entails a very different way of understanding the shifting practices from high-carbon to low-carbon, especially in rapid time frames. In particular, I would make for a more consistent analysis with the focus on socio-technical transitions earlier in the chapter, since that approach also expresses the methodological individualism underlying the discussion in this passage and focuses on the complex relations between identities, daily practices, and technology and infrastructure. [Matthew Paley-Ram, United Kingdom (of Great Britain and Northern Ireland)]

**Response:**

```
Taken into account. Conceptual factors are discussed on p. 57, the 15-20, identities are discussed on p. 58. S t e r t i c k ( 1 5 - 2 0 ) t r a n s i t i o n s are discussed in section 4.2.3. Please note that page and the numbers refer to the FOD.
```

**3091**

**From Line:** 1

**To Line:** 30

**Comment:** 4.4.5.1-3 are good, well written [Christopher Bataille, Canada]

**Response:**

```
Noted.
```

**15046**

**From Line:** 7

**To Line:** 7

**Comment:** It is agreed that the title of chapter includes ‘threat’, somewhere in this section on enabling lifestyle & behavioural change there should be discussion of psychological threat responses (defence or coping strategies) such as denial, and also the influence of denialism (i.e. deliberate campaigns of disinformation) that spread doubt in people’s minds about the science, contributing to inertia. [Elvira Poloczanska, Germany]

**Response:**

```
Taken into account. There is a lack of literature on behaviour change specific on 1.5 degree. Yet, similar strategies can be implemented for scenarios consistent with 2C or 1.5C, but more strongly so. Stronger technical behaviour change is key for 1.5C (see Chapter 2), so an assessment of this literature is important. We assess reviews and meta-analysis wherever possible, and rely on high quality peer-reviewed papers elsewhere.
```

**11474**

**From Line:** 3

**To Line:** 3

**Comment:** I am glad to see this section headed “Enabling…”. I still suggest though it be headed “Enabling sustainable lifestyles and behaviours” to acknowledge the chapter, since that approach also eschews the methodological individualism underpinning the discussion in this passage, and focuses on the complex relations between identities, daily practices, and technology and infrastructure. [Matthew Paley-Ram, United Kingdom (of Great Britain and Northern Ireland)]

**Response:**

```
Taken into account. The title of chapter includes ‘threat’, somewhere in this section on enabling lifestyle & behavioural change there should be discussion of psychological threat responses (defence or coping strategies) such as denial, and also the influence of denialism (i.e. deliberate campaigns of disinformation) that spread doubt in people’s minds about the science, contributing to inertia.
```

**20123**

**From Line:** 7

**To Line:** 7

**Comment:** It would be helpful to include somewhere in this section an indication of the scale of behavioural changes that are both needed and possible. Chapter 2 talks about 1.0°C pathways involving 20% final energy demand reductions in 2050. This chapter should indicate how much of this might come from technology and how much from behaviour [Laurence Michaelis, United Kingdom (of Great Britain and Northern Ireland)]

**Response:**

```
Taken into account. This is discussed in Chapter 2, which types of behaviour changes can contribute to 1.5°C pathways is now discussed in this section (previously included in section 4.2.3). Technology change involves behaviour change (i.e. people need to adopt or accept the relevant technology).
```

**20214**

**From Line:** 7

**To Line:** 7

**Comment:** In industrialized countries household energy use can vary by a factor of 40 between households, and a factor of 3 to 4 between homogeneous households (J. Moriory and Hazen, M. The significance of difference. Understanding variation in household energy consumption. ECEEE Summer Study 2011, Panel 8.) [Laurence Michaelis, United Kingdom (of Great Britain and Northern Ireland)]

**Response:**

```
Taken into account. This is exactly why it is important to understand which factors affect behaviour change the focus of this chapter. We now which types of mitigation and adaptation are relevant for 1.5C.
```

**20215**

**From Line:** 7

**To Line:** 7

**Comment:** Individuals and groups adopting transition free household energy use, eating data free from meat and dairy products, and refraining from flying or car use can achieve personal carbon footprints at least 60-70% below the industrial country average. [Laurence Michaelis, United Kingdom (of Great Britain and Northern Ireland)]

**Response:**

```
Taken into account, see comment 20213, we added a Table.
```
IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4

20216 S7 3 Some ecologists have per capita ecological footprints 50-60% below their national averages (S. Timley and George, H., Ecological Footprint of the
Freshman Foundation and Community. Sustainable Development Research Centre, Mony, 2006; M. Daly, 2017. Quantifying the environmental impact of
ecovilages and co-housing communities: a systematic literature review, (J. Justice and Sustainability, vol. 22 no. 11)).[Laurence Michaels, United
Kingdom (of Great Britain and Northern Ireland)]

Taken into account, see reply to 20213

20217 S7 3 In one scenario for the UK final energy demand is reduced by 85% in between 2010 and 2030 through a combination of technology and
behavioral change. It includes 15% less travel per mode shift, including a factor of three reduction in air travel. (P. Allen, Blaire L. Harper, P., Holster-Strout, A.,
Kingdom (of Great Britain and Northern Ireland)]

Taken into account, see reply to 20213

2705 S7 3 47 Enabling Wakeful and behavioural change are important. However, I would have preferred some discussions around the need for reducing the global
human population. (Aage Stangeland, Norway)

Accepted, now included

10222 S7 4 For me this section was too all encompassing and too long, covering material better suited to ARB, could you focus on the part directly relevant to
SR11.37 (Paris Pandemic, United Kingdom (of Great Britain and Northern Ireland))

Taken into account, all factors and strategies are directly relevant to 1.5, given high ambitions all strategies may be needed, see comment 20214. Moreover, the text is shortened.

11475 S7 5 Among those who are, in general terms, materially well off (Stewart Locurcio, Australia)

Taken into account, not only materially well off - also refers to adaptation, so we did not add this

11476 S7 5 64 38 These summaries of the literature are generally quite good but more qualification is needed to avoid the suggestion that each piece of research is
generable to all people. Most of the studies are undertaken with citizens of high income, developed and predominantly Western countries. Some are not and it might be
the case that there is more variability within countries on these consumption-related matters than there is between countries. But still, it is supposed to be
a research-based report and all claims should be qualified in respect to just how generalizable they are on the current evidence. (Stewart Locurcio, Australia)

Taken into account, we indicate that factors influencing behaviour and effects of strategies differ across individuals and context. We included more literature from non-Western countries. We refer
in meta-analyses and review papers whenever possible, and many papers refer to studies outside EU and Northern America

20260 S7 6 57 10

Accepted, included

20218 S7 9 57 9 Individuals who identify as members of certain groups, including those with particular political views...[Laurence Michaels, United Kingdom (of Great Britain and Northern Ireland)]

Rejected- unclear what the comment is about

4997 S7 13 62 55 Sections 4.4.3.1, 4.4.3.2, 4.4.3.3 overall appear lengthy and overly thematic. In particular section 4.4.3.2 "Behavioural anomalies" seems rather not well
balanced, overall theoretical and overall of limited added value in the context given here. Most information that is useful would fit under the previous
section 4.4.3.1 "Parties related to climate change action". The two sections should be merged and content shortened. The next section "Strategies to
promote actions on climate change should also be revised" it can be shortened and better focused. (Sigrid Rutsch, Germany)

Accepted. We revised and shortened the text, and integrated 4.4.3.2 in 4.4.3.1.

11429 S7 13 60 40 These two sections provide a good overview of the motivational/reflective aspects and cognitive choice aspects of individual behaviour change. They
could be considerably shortened by cutting connecting text and using lists or bullet points of the many observations from the literature. The chapter is largely
repetitive from perspectives studies of human collective - social psychological, sociological, anthropological and organisational change and
management. This is important because much consumption and behaviour is shaped by social norms and narrative. (Laurence Michaels, United
Kingdom (of Great Britain and Northern Ireland))

Taken into account, social norms are discussed, stem group influence (page 58 line 28-33), page 62 (line 8-14), we did not always use term social norms to avoid jargon, rather describe the
social influences (as only limited space available). We added link to behaviour in organisations. Text has been shortened

4998 S7 25 57 28 The way this is formulated now suggests IPCC is the home of self-righteous, illiberal, interventionist, authoritarian wascasses, leaving no room for diversity of
career conceptions of wellbeing. Even if it’s not - it’s not the role of IPCC to do so. [Marcos Wissenburg, Netherlands]

Taken into account, different conceptualisations of wellbeing and lifestyles are taken into account (see reply to 20222)

18491 S7 35 57 36 Gobranlek, Sig & Vitek mendeley ink (Wilfran Moufouma Okia, France)

Taken into account, see reply to 20213

4192 S7 41 55 Additionally, lack of knowledge means that the entire lifestyle emissions of energy sources are entersoxidized allowing individuals to favour some mess
over others when there could be cleaner and more affordable options. If we are to communicate the importance of sustainable development then it is
likely that all energy sources are transparent with the amount of resources used, environmental impacts, carbon offset, history current technologies and the plan for waste disposal or recycling at end of life. (Michelle Lelles, UK)

Taken into account, the main point made in text, lack of knowledge may inhibit behaviour change. But we also indicate that estimating knowledge may not result in changes in preferences as knowledge is not a strong predictor of behaviour

4803 S7 41 57 41 It is not so much lack of knowledge as different ideas of the good life, different ethics and moralities, different priorities that explain non-compliance with
what IPCC presents as the sensible way of life. Texts like the (apologies for the repetition) IPCC must be aware that the media is often different. It cannot
continue to be left to the hands of journalists. The international community that has funded the scientific
documentation of climate change must now give the same financial backing to the dissemination of climate change. There is, as Dr Juan Salazar states a
need to create intersubjective spaces of communication and association to interest the public in the public interest" (Salazar 2011) where the basis for
engaging climate change is not information but conversation and the cultivation of a culture of communication. [Marcos Wissenburg, Netherlands]

Accepted, the effects of information is discussed later, in section 4.4.3.2 (now 4.4.3.1)

20261 S7 41 57 42
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
7954 | 57 | 41 | 57 | 55 | include references / mention of the developments of a global Circular Economy and transition from a Linear to a Circular system e.g Knowledge based actions | Taken into account elsewhere, different types of behavioural changes that would limit GHG emissions are discussed in 4.4.3.

15 | 57 | 44 | 57 | 45 | It is highly relevant to note that "people overestimate savings for low-energy activities, while they underestimate savings for high-energy activities", but | Accepted, yet the study Allert et al. indicates that people underestimate energy savings, not overestimate, we indicated this.

6095 | 57 | 46 | 57 | 47 | The reference to "the mitigation potential of limiting meat consumption" is misleading, and should be replaced by a reference to the mitigation potential of limiting the consumption of red meat / animal products (which includes e.g. dairy products). Per-sawing, not only current meat, but also dairy are more emissions intensive than fish and pork (see e.g. Tilman and Clark). | Taken into account. The particular lead refers to a study on public understanding on energy use related to meat consumption, so it did not deal with dairy products. The climate impact of meat and dairy consumption is included in table 4.1

4098 | 57 | 47 | 57 | 49 | It does not seem necessary to point out here that some individuals do not really know the definition of 'renovable energy'. Please consider deleting this (it might be corrected, but is not a key issue here, and it is not of help to address the citizen as a partner. | Taken into account, we left it in now and clarified that it makes clear that knowledge is not always accurate which may inhibit effective climate action

14295 | 57 | 48 | 57 | 49 | For example, some individuals think natural gas is a renewable energy source of high feed and involves burning materials (Bulter et al. 2013; Devere-Wright 2003). | Taken into account, we do not use or distribute page 124 of 159

18492 | 57 | 49 | 57 | 50 | Taylor et al. 2014 needs Mendeley link [Wilfran Moufouma Okia, France] | Taken into account, the paper by Law et al. and Fuster et al. focus on predictions of climate change awareness and risk perceptions, not on behaviour which is the focus of this section. Assessment of the literature reveals that affects of knowledge on climate action is limited as we indicate in text

14332 | 58 | 1 | 58 | 25 | The paper MORRISON, F. BACELAR-NICOLAU, P. REIDERS-VON OSTER, J. SANITOS, P. BACELAR-NICOLAU, L. FALCO, H. ALVES, F. SOARES, A. AZIETERO, U. 2017. Assessing University Student Perceptions and Comprehension of Climate Change (Portugal, Mexico and Australia). International Journal of Climate Change Strategies and Management, 9:33-46. DOI: 10.1108/IJCCSM-08-2016-0123 | Taken into account, this paper also focuses on climate change awareness and risk perceptions, not on behaviour which is the focus of this section. Assessment of the literature reveals that affects of knowledge on climate action is limited as we indicate in text

7285 | 58 | 3 | 59 | 22 | The sentence links the rejection of climate change knowledge to particular political views. A recent paper establishes a direct link that is missing in the cited literature. | Taken into account, we leave it here as it fits well with the discussion.

14893 | 58 | 6 | 58 | 6 | Abrahamse et al. 2005 needs Mendeley link [Wilfran Moufouma Okia, France] | Taken into account, we leave it here as it fits well with the discussion.

14944 | 58 | 7 | 58 | 7 | Chai et al. 2017; Myers 2012, Science 2011 need Mendeley links [Wilfran Moufouma Okia, France] | Taken into account, we leave it here as it fits well with the discussion.

14971 | 58 | 9 | 58 | 12 | The section refers to the rejection of climate change knowledge to particular political views. A recent paper establishes a direct link that is missing in the cited literature; the link between cultural worldviews (the Kahn et al. reference) and rejection of policies: Berry, T.L., Kalsbeek, B., Skov, S., Accepting market failure: Cultural worldviews and the opposition to corrective environmental policies, Journal of Environmental Economics and Management, 195:203-204, 2017. [Wilfran Moufouma Okia, France] | Taken into account, we leave it here as it fits well with the discussion.

14995 | 58 | 10 | 58 | 10 | Kahn et al. 2010; Chai et al. 2013 need Mendeley links [Wilfran Moufouma Okia, France] | Taken into account, we leave it here as it fits well with the discussion.

14996 | 58 | 11 | 58 | 11 | King et al. 2011; McCaffrey et al. 2011 need Mendeley links [Wilfran Moufouma Okia, France] | Taken into account, we leave it here as it fits well with the discussion.

7045 | 58 | 12 | 58 | 12 | Consider mentioning, Licciare, political leadership (elite cues) [Vanclay (public attitude) on climate change] Brule et al. 2012, Schönborg 2012 Brule, R.J., Carmichael, J., and Jenkins, J.C., 2012. Shifting public opinion on climate change: an empirical assessment of factors influencing concern over climate change in the US, 2010-2010. Climate Change, 114 (2), 169-186. Schönborg, J. 2018. The Effect of Elite Polarization: A Comparative Perspective on How Party Elites Influence Attitudes and Behavior on Climate Change in the European Union. Sustainability, 9 (1), 35. [Corin Little, Denmark] | Taken into account, included in section 4.4.3, in the paragraph below Figure 4.4

14997 | 58 | 12 | 58 | 12 | Barca and Bezegh 2013 need Mendeley links [Wilfran Moufouma Okia, France] | Taken into account, we leave it here as it fits well with the discussion.

7096 | 58 | 13 | 58 | 13 | The role: Barca and Bezegh 2012 in missing from the References section. [Corin Little, Denmark] | Taken into account, we leave it here as it fits well with the discussion.

14998 | 58 | 16 | 58 | 16 | Date 2013; Step 2016 need Mendeley links [Wilfran Moufouma Okia, France] | Taken into account, we leave it here as it fits well with the discussion.

14997 | 58 | 19 | 58 | 19 | What is meant by 'market-friendly'? It's unclear in this context [Jason Donev, Canada] | Taken into account, we leave it here as it fits well with the discussion.

14999 | 58 | 20 | 58 | 20 | Kassem et al. 2007 need Mendeley links [Wilfran Moufouma Okia, France] | Taken into account, we leave it here as it fits well with the discussion.

3622 | 58 | 20 | 58 | 44 | The motivation factors to encourage renewable energy adoption (FAST 2013) has shown that use of market tools like feed in tariff programs can increase individual and community evaluation away from climate benefits and towards economic evaluation, thereby constraining discussion and rationale in ways that may have long term impacts on potential for longer term commitments to ghg reduction [Stewart Fast, Canada] | Taken into account, this topic is discussed in 4.4.3 (now 4.4.3.3)

18550 | 58 | 21 | 58 | 21 | Diez et al. 2010; Step 2016; Taylor et al. 2014 need Mendeley links [Wilfran Moufouma Okia, France] | Taken into account, we leave it here as it fits well with the discussion.

Do Not Quote, Cite, or Distribute Page 124 of 159

Page 124 of 159
Comment Response

14288 58 21 58 22 People who strongly value protecting nature, the environment and other people are more likely to act on climate change than those who strongly value personal hedonic and egotistic values. Yet, we find that people with high values in all four domains are equally likely to act on climate change. Taken into account. The statement reflects findings in the literature, generally people with strong values act more pro-environmentally, but not always consistently, eg because they lack knowledge - which is discussed in this section

18501 58 23 58 23 Jansen 2011; Wolkse et al. 2017 need Mendeley links [Wilfran Moufouma Okia, France] editorial

18502 58 25 58 26 Bamberg and Moser 2001; Wolkse et al. 2017 need Mendeley links [Wilfran Moufouma Okia, France] editorial

18503 58 26 58 26 Parrow et al. 2017 needs a Mendeley link [Wilfran Moufouma Okia, France] editorial

18504 58 30 58 30 Bamberg and Moser 2001; the four other refs need Mendeley links [Wilfran Moufouma Okia, France] editorial

18505 58 31 58 31 Wolkse et al. 2017; Singh et al. 2017 need Mendeley links [Wilfran Moufouma Okia, France] editorial

18506 58 33 58 33 Bratå et al. 2016 Fielding & Hornsey 2016 [Wilfran Moufouma Okia, France] editorial

18507 58 37 58 37 Coelho et al. 2016 the three other refs need Mendeley links [Wilfran Moufouma Okia, France] editorial

18508 58 38 58 38 Viepeljen & Roy 2015 needs a Mendeley link [Wilfran Moufouma Okia, France] editorial

18509 58 40 58 40 Liberman et al. 2013 needs a Mendeley link [Wilfran Moufouma Okia, France] editorial

17237 58 40 58 40 Change satisfied to: Alfro [Wilfran Moufouma Okia, France] editorial, changed into feelings

18510 58 48 58 48 Selke et al. 2016 needs a Mendeley link [Wilfran Moufouma Okia, France] editorial

18511 58 48 58 48 Steig et al. 2015 needs a Mendeley link [Wilfran Moufouma Okia, France] editorial

18512 58 49 58 49 Zevit et al. 2015 needs a Mendeley link [Wilfran Moufouma Okia, France] editorial

18513 58 51 58 51 Azeiton and Steig 2009 and the five other references need a Mendeley link [Wilfran Moufouma Okia, France] editorial

3985 58 54 58 54 to engage [Christopher Bataille, Canada] editorial

18514 58 54 58 54 Fielding and Head 2012 needs a Mendeley link [Wilfran Moufouma Okia, France] editorial

9397 58 54 58 54 There is a missing word “if” in the phrase “be able to engage in climate change actions” [Sar KLUNIS, Turkey] editorial

1219 59 60 The “behavioural anamnesis” described here in 4.4.5.3 are only anamnesis if viewed through the lens of rational choice theory, which itself is perceived as an anomalous approach to understanding how human beings act outside of the neo-classical economic model. Perhaps the whole section (4.4-5) would benefit from addressing policy, economic, cultural and psychological barriers and enablers of lifestyle and behavioral change in separate sub-sections? [Pete Tschakert, Australia] editorial

18515 59 1 59 1 Barbara et al. at 2017 and the five other references need a Mendeley link [Wilfran Moufouma Okia, France] editorial

14289 59 1 59 22 This section was fascinating, but how strong is the evidence? How sure are the conclusions? This report has been inconsistent with using the defined heading and the language in the section about behavioural anomalies contributes to the view that the IPCC's approach to mitigation is dominated by an economical way of thinking in a world outside of the neo-classical economic model. [Jason Donev, Canada] editorial

18516 59 4 59 4 Van der Werff et al. 2017 needs a Mendeley link [Wilfran Moufouma Okia, France] editorial

18517 59 12 59 12 Janssan 2011; Wolkse et al. 2017 need Mendeley links [Wilfran Moufouma Okia, France] editorial

18518 59 13 59 13 Foster et al. 2014 needs a Mendeley link [Wilfran Moufouma Okia, France] editorial

9897 59 16 59 16 Taken into account. We included a reference to a review paper on gender roles (Bunce & Ford 2015). Gender is further discussed in Chapter 5 [Jason Donev, Canada] editorial

18519 59 15 59 15 Ewert et al. 2016 needs a Mendeley link [Wilfran Moufouma Okia, France] Editorial

18520 59 15 59 15 Gouveia et al. 2015 and Grothmann and Reusswig 2005 need a Mendeley link [Wilfran Moufouma Okia, France] Editorial

18521 59 18 59 18 Chang et al. 2014 Molina and Barnett. 2009 need a Mendeley link [Wilfran Moufouma Okia, France] Editorial

4025 59 19 59 22 Cultural heritage, held in both tangible places, buildings, sites, and in intangible knowledge and stories, is a critical component of individual and community attachment to place. The importance of cultural heritage in representing ties to place and the potential impact of loss of heritage due to climate change should be incorporated here. Relevant points and references include: due to requests of Small Island Developing States, loss of heritage is now included as part of the UN Framework Convention on Climate Change Warsaw Mechanism for Non-Economic Loss and Damage. As well, on 6 October 2016, the UN Council on Human Rights adopted resolution 32/20, which recognizes cultural heritage as a right in the face of intentional destruction. While climate change has not yet been treated as intentional destructive force, the implications and importance of cultural heritage in identity is relevant here. The effects of climate change on world heritage and tourism is described in: Markenfs, A., Opschoor, E., Luijster, Sierman K and Calsdes, A. (2015), World Heritage and Tourism in, in: 3: Cultural Change, Climate Change, United Nations Environment Programme, Nairobi, Kenya and United Nations Educational, Scientific and Cultural Organization, Paris, France. And a detailed listing of current research and field observations of the impacts of climate change on cultural heritage is included in the recent US government report. Rosenb, J. Merida, Marissa Mangan, Sonya Davis, George Hemphire, and Alison Meadow. 2016. Cultural Resources Climate Change Strategy. Washington, DC: Cultural Resources, Partnerships, and Science Climate Change Response Program, National Park Service, see Graphic 2, available at: https://www.nps.gov/sjrs/news/climatechange/culturalresourcesstrategy.htm. [Maryse Rockman, United States of America] Accepted, we now refer to heuristics and mental shortcuts

18522 59 21 59 21 Adger et al. 2013 needs a Mendeley link [Wilfran Moufouma Okia, France] Editorial

18523 59 25 59 25 The previous section has outlined a good range of the factors that shape human behaviour and this section continues in helpful material. However, the wording and the language in the section about behavioural anamneses contributes to the view that the IPCC's approach to mitigation is dominated by anamnesis. These are only one aspect to human behaviour for a theory that expects people to follow a particular kind of rationality. An anomaly is something that differs from what is normal or expected. If rational choice theory pretends to describe normal or expected behaviour, it is simply wrong! [Laurence Michaelis, United Kingdom (of Great Britain and Northern Ireland)] editorial

11047 59 25 59 25 “What makes a’human’? What binds us? Is ‘animality’ a no surprise for other assimilists or cultural ecologists. Please use a more realistic term. [Oliver Gaden, Germany]” editorial

IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4

Do Not Quote, Cite, or Distribute Page 125 of 159
Behavioral anomalies is a very critical term to use, and it has been applied in various parts of the text. The state-of-the-art on behavioral insights has already disposed of the myths around human rational thinking and it made clear that human behavior in response to various factors, most often not driven by rationality. In this sense, calling this an ‘anomaly’ gives the impression that behaving in a nonrational way is out of the normality, when in reality this is how the brain functions in most situations. The literature that supports this comment is vast, for a few examples: Mont, O. et al (2013). Improving Nordic policymaking by dispelling myths on available consumption. Nordic Council of Ministers 2013; Steg, L.; Vlek, C. (2009). Encouraging pro-environmental behavior: an integrative review and research agenda. In: Journal of environmental psychology 29 (2009) 309-317; Mariana Nicolau, Germany.

Accepted, we now refer to heuristics and mental shortcuts.

We refer to the density of the literature on the topic, staying that it is too numerous and can’t be covered in this section. This is not a valid criticism, as the comments have been taken into account and discussed in the section on habits and mental shortcuts.

The particular example of Mozambique is taken from Patt and Schroter (2008)’s influential paper, and the effects of strategies varies across contexts and individuals so difficult to generalise.

The section could be cut or drastically shortened. It reads more like background theory than an assessment. [Penny Urquhart, South Africa] Accepted, we shortened the text and integrated it in 4.4.5.1 (now 4.4.3.1), and shortened and we no longer refer to anomalies. See response to 11047.

It is not clear what the comment is about. [Christopher Bataille, Canada] Rejected - unclear what the comment is about.

This section could be cut or drastically shortened. It reads more like background theory than an assessment. [Penny Urquhart, South Africa] Accepted, we shortened the text and integrated it in 4.4.5.1 (now 4.4.3.1), and shortened and we no longer refer to anomalies. See response to 11047.

Do not Quote, Cite, or Distribute Page 126 of 159

IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4

Page 126 of 159
The chapter on “strategies to promote actions on climate change” is interesting and relevant, but it lacks sufficient attention to potential rebound or negative spillover effects (rebound effects are mentioned, but only in general in the first paragraph). I suggest to include some of these less optimistic findings. Suggested text: Truelove et al. (2014) find that “to date research on spillover effects has generated mixed results at times confounding the existing evidence.” These mixed results find that individuals who have more pro-environmental attitudes or engage in more voluntary environmental behaviors, do not necessarily have a smaller ecological footprint than those who do not (Barr et al. 2010; Cauduro 2012). Other studies find that environmental behavior in one area can - to some extent - spill over to promote motivation for environmentally friendly behavior in other domains (Thagerson 1999; Thagerson and Chan 2003). Various mechanisms have been proposed to explain these types of spillover effects, including positive and negative motivational crowding (Frey and Jegen 2007), economic rebound effects (Braaenenger 2001), moral or psychological rebound effects such as single action bias (Weber 1997) or moral licensing (Miller and Efton 2010), mental accounting (Thaler 1985), and several more. [Steffen Kalbekken, Norway]

Taken into account, now indicated that some studies suggest moral licensing may occur too, with reference to review by Truelove et al. The finding that low environmental concern does not necessarily mean low ecological footprint is not an indication of negative spillover or moral licensing, but reflects that strong pro-environmental attitudes do not always translate into behavior, and highlights that other factors may play a role (e.g. opportunities). We discuss this in the draft section 4.4.5.1 (now 4.4.3.1). Motivational crowding is discussed on p. 61, line 19-28. Page and line numbers refer to FOD.
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
18540 | 61 | 33 | 61 | 33 | Stern et al. 2016 needs a Mendeley link [Wilfran Moufouma Okia, France] | Editorial
17139 | 61 | 36 | 61 | 36 | It is better to change the word from "adaptation" to "adaptability" [Kajithra Kishore, India] | Editorial
18541 | 61 | 36 | 61 | 36 | Singh et al. 2017 needs a Mendeley link [Wilfran Moufouma Okia, France] | editorial
18542 | 61 | 38 | 61 | 38 | Abrahamse et al. 2020 and the other four references need a Mendeley link [Wilfran Moufouma Okia, France] | editorial
18543 | 61 | 41 | 61 | 41 | Campbell and Kay 2014 need a Mendeley link [Wilfran Moufouma Okia, France] | editorial
18544 | 61 | 42 | 61 | 42 | Abrahamse et al. 2020 needs Mendeley link [Wilfran Moufouma Okia, France] | editorial
18545 | 61 | 44 | 61 | 44 | Abrahamse et al. 2017 need a Mendeley link [Wilfran Moufouma Okia, France] | editorial
958 | 61 | 46 | 61 | 46 | This point discusses heat waves and information being targeted to vulnerable populations. It could also be mentioned that emergency response plans have also found to have an impact on improving adaptation to these events. For example, this paper has assessed the performance of one of these response plans - Beremahare, T., Baize, Y., Kalé, D., Auger, N., King, N., & Kaufman, J. (2016). A difference-in-differences approach to assess the effect of a heat action plan on heat-related mortality, and differences in effectiveness according to sex, age, and socioeconomic status (Montreal, Quebec). Environmental health perspectives, 124(11), 1584. [Thomas Longden, Australia] | Accepted, included now
18546 | 61 | 47 | 61 | 47 | Keim 2008; Vandenbroucke et al 2006 need a Mendeley link [Wilfran Moufouma Okia, France] | editorial
18547 | 61 | 50 | 61 | 50 | Samet and Solomon 2003; Solomon 2017 need a Mendeley link [Wilfran Moufouma Okia, France] | editorial
18548 | 61 | 51 | 61 | 51 | Patil et al. 2016 need a Mendeley link [Wilfran Moufouma Okia, France] | editorial
18549 | 61 | 52 | 61 | 52 | Wilber and Her 2012 need a Mendeley link [Wilfran Moufouma Okia, France] | editorial
18550 | 61 | 55 | 61 | 55 | Mean et al. 2011 need a Mendeley link [Wilfran Moufouma Okia, France] | editorial
1094 | 62 | 62 | 62 | The statement in Chapter 4, "Overall, energy efficiency rebound effects are limited and energy efficiency improvements are not reversed by the rebound effect" (section 4.4.5.3 p. 4-42, line 40-46), is, in my opinion, at minimum highly uncertain, and very likely incorrect. Rebound magnitudes are likely high [3,4,5,6,7,9,10,11,12,13,23,26,27]. There is evidence of backfire in some countries, certain circumstances, and some sectors [9,10,23]. See also comments for sections 2.3, 2.4, 2.5. | Taken into account, we removed the text on the rebound effect
1095 | 62 | 62 | 62 | The economic modeling paradigm is different for these two sectors because whereas the household sector involves household preferences, productive economy decision making involves profit-maximizing behavior. This is not adequately comprehended in the Gillingham et al. work. Not only does the productive economy use the most energy, it is also where significant efficiency technologies have been at work and are planned, so rebound estimates need to comprehend this. The vast bulk of energy use becomes "embedded" in goods and services delivered to households. The total energy embedded in goods and services is shaped by household choices among them [7, yes, but importantly, it is also driven by producer technology choices, flexibility and efficiency investments. [HARRY SAUNDERS, United States of America] | Taken into account, we removed the text on the rebound effect
1096 | 62 | 62 | 62 | References Cited
3. Roy, J.; Sathaye, J.A., Khaddaria, R. (2006), "Substitution and price elasticity estimates using inter-country pooled data in a translog cost model," Energy Economics 28, 706-719, [substitution elasticities are likely higher than commonly used in IAMs] [HARRY SAUNDERS, United States of America] | Taken into account, we removed the text on the rebound effect
Lokhorst et al. 2013; Abrahamse et al. 2005; Abrahamse and Steg 2013 need a Mendeley link

Osbaldiston and Schott 2012

Steg 2016 needs a Mendeley link

Lu et al. 2016 needs a Mendeley link

Abramhamse and Steg 2013 need a Mendeley link

Lindenberg and Steg 2013; Robertson & Barling 2015; Stern et al., 2016 need a Mendeley link

Middlemis 2011; Seyfang and Haxeltine 2012 need a Mendeley link

Brugger et al. 2015; Carrico et al. 2015 need a Mendeley link

Abramhamse and Steg 2013 need a Mendeley link

Osbaldiston and Schott 2012; Steg 2016 needs a Mendeley link

Gillingham, Rapson, & Wagner, 2016 need a Mendeley link

Lauren et al. 2016 needs a Mendeley link

Adger et al. 2003 needs a Mendeley link

Darby 2006; Tiefenbeck et al. 2017 need a Mendeley link

The museum can provide arenas for face to face interaction

Good to include this, but needs a reference

Juhl et al. 2017 needs a Mendeley link


2. Saunders, H.D. (2011). “Mitigating Rebound with Energy Taxes.” (unpublished): https://works.bepress.com/harry_saunders/28/ [Mitigation of rebound can be at the level of household or the level of the economy, and could be done through tax policy]


Do Not Quote, Cite, or Distribute Page 129 of 159
### Comment Response - Chapter 4

<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>18571</td>
<td>62</td>
<td>53</td>
<td>62</td>
<td>53</td>
<td>The chapter on “acceptability of policy and system changes” is very important, but the survey of the literature seems ed hoc (it needs to much like a bullet point list and not enough like an integrated review). I suggest a more systematic review by Drews and van den Bergh, and perhaps reuse some of the classifications of the literature they employ.</td>
<td>Accepted. The text is rephrased to avoid confusion. The literature assessed focuses on policy aimed to promote behavior change.</td>
</tr>
<tr>
<td>18572</td>
<td>62</td>
<td>53</td>
<td>63</td>
<td>46</td>
<td>The chapter includes a very substantial section on fairness (section 4.4.5.4) which is relevant.</td>
<td>Accepted. We revised the text, now discuss additional factors and included both references.</td>
</tr>
<tr>
<td>18573</td>
<td>62</td>
<td>53</td>
<td>62</td>
<td>53</td>
<td>What is the difference between section 4.4.6.1 and section 4.4.6.2? Section 4.4.6.2 is basically about ICTs, so the authors may consider a new title for that section.</td>
<td>Accepted. We fully agree, and discuss a wide range of strategies for behavior change, including social network approaches see section 4.4.5.3 of FOD; ep 61 line 12-14, and approaches targeting identity, ep 62 line 50-54</td>
</tr>
<tr>
<td>6219</td>
<td>63</td>
<td>3</td>
<td>63</td>
<td>47</td>
<td>The statement “Policies and system changes need public support” is highly under-specific. What the term public support means here is unclear. If it is intended to mean all people support it, then the statement is demonstrably false, and there is no literature in political science that would support such a claim. But if it doesn’t mean that, then it means that policy needs support from a specific section of a population? If so, how much? Or does it mean that policy needs simply to be imposed by a significant number of people (i.e. a notion of tacit consent)? And crucially, how is that public support mediated in a political system? In authoritarian and democratic systems this is very different, but even in democratic systems, the electoral system, access to policy-makers via lobbying, and so on, make it important differences how policy-makers have to take account of popular opinion. There is a real small but emerging literature on this in climate policy (see for example Lachapelle, Enric, and Matthew Paterson. 2013. Greens of National Climate Policy. Climate Policy 13:547–71, and various discussions in AR5 WGI. (2015). How this is then affected by a focus on 1.5C however is an important question, but more generally, this account needs to think about the political nature of the individual receiving the message (Kahan, 2012). In particular, there is a clear and consistent relationship between a adherence to a laissez-faire (“free market”) economic perspective and scepticism about climate change (McIntyre &amp; Dunlap, 2011).”</td>
<td>Taken into account. Indeed knowledge of CC is not the primary driver of public engagement, values, worldviews and political ideology are much more fundamental in shaping views about energy and climate change (Corner, Markowitz, &amp; Pringle, 2014; Horsey et al. 2016). As numerous studies have shown, messages about climate change (and the perceived trustworthiness and reliability of the message communicator) are dependant on the political orientation of the individual receiving the message (Kahan, 2012). In particular, there is a clear and consistent relationship between adherence to a laissez-faire (“free market”) economic perspective and scepticism about climate change (McIntyre &amp; Dunlap, 2011).”</td>
</tr>
<tr>
<td>7139</td>
<td>63</td>
<td>3</td>
<td>63</td>
<td>47</td>
<td>Update to Singapore - a new vehicle emissions scheme was announced in 2017 and will be implemented in 2018 to improve air quality and also to include fairness related factors influencing public acceptability of climate policy and system changes. The paper by Whinney &amp; Beaumont focuses on fair and effective multifacilalism, which does not fit in the present sections, but is related to governance.</td>
<td>Taken into account. The text is rephrased to avoid confusion. The literature assessed focuses on policy aimed to promote behavior change.</td>
</tr>
<tr>
<td>7140</td>
<td>63</td>
<td>8</td>
<td>63</td>
<td>8</td>
<td>Comment: There is a wide range of literature demonstrating that public support for action on climate change is more complex than currently described. One of the greatest factors determining public support is political values and their association, either positively or negatively, with the issues of climate change and related issues. In addition it has been determined that the information deficit model of communication has limited success when it comes to engaging populations and it is vital to employ effective communication techniques based around human values whilst understanding the importance of social and cultural factors (Corner, A. J., Markowitz, E., and Pringle, N. F. (2014). Public engagement with climate change: the role of human values. Wiley Interdisciplinary Reviews: Climate Change, 5(1), 411-422.)</td>
<td>Taken into account. Indeed knowledge of CC is not the primary driver of public engagement, values, worldviews and political ideology are much more fundamental in shaping views about energy and climate change (Corner, Markowitz, &amp; Pringle, 2014; Horsey et al. 2016). As numerous studies have shown, messages about climate change (and the perceived trustworthiness and reliability of the message communicator) are dependant on the political orientation of the individual receiving the message (Kahan, 2012). In particular, there is a clear and consistent relationship between adherence to a laissez-faire (“free market”) economic perspective and scepticism about climate change (McIntyre &amp; Dunlap, 2011).”</td>
</tr>
<tr>
<td>3722</td>
<td>63</td>
<td>15</td>
<td>63</td>
<td>19</td>
<td>The case to include fairness applies to multi-lateral processes explicitly.</td>
<td>Taken into account. Accepted. We revised the text, now discuss additional factors and included both references.</td>
</tr>
<tr>
<td>3623</td>
<td>63</td>
<td>15</td>
<td>63</td>
<td>26</td>
<td>a reference or acknowledgment of the increasing health concerns being expressed around wind turbine noise (Council of Canadian Academies,2015) would be in order here. Possibly tying it to the concept that health impacts are mediated by procured fairness concerns – i.e., health risk are exacerbated by procedural fairness concerns – and policies that aim to quickly deploy wind energy infrastructure may need to be tempered to allow opportunities for local zoning control, altering energy feeds etc for large scale renewable infrastructure to sustain broad public support. (Fast et al at 2016. Bateer and Walker 2013)</td>
<td>Taken into account. Accepted. We revised the text, now discuss additional factors and included both references.</td>
</tr>
<tr>
<td>5150</td>
<td>64</td>
<td>3</td>
<td>64</td>
<td>11</td>
<td>Update to Singapore - a new vehicle emissions scheme was announced in 2017 and will be implemented in 2018 to improve air quality and also to include fairness related factors influencing public acceptability of climate policy and system changes.</td>
<td>Taken into account. The scheme will be implemented in 2018 as the effects can not be assessed yet</td>
</tr>
<tr>
<td>4754</td>
<td>64</td>
<td>4</td>
<td>64</td>
<td>4</td>
<td>Remove comma in “White, these, which become White these” [Valenzuela, Piazza, Italy]</td>
<td>Editorial</td>
</tr>
<tr>
<td>4193</td>
<td>64</td>
<td>29</td>
<td>35</td>
<td></td>
<td>Did the number of vehicles decrease because people cared about climate change or because they couldn't afford to drive? [Michelle Leslie, Canada]</td>
<td>Taken into account. Accepted. A case study onaviour in Brazil, adressing both innovation and international linkages, was asked.</td>
</tr>
<tr>
<td>17240</td>
<td>64</td>
<td>39</td>
<td>64</td>
<td>39</td>
<td>Case study of international linkages for enhancing technology transfer from Climate &amp; Clean Air Coalition, International Solar Alliance, etc could be given [Nterangaene Gupta, India]</td>
<td>Accepted. A case study onaviour in Brazil, adressing both innovation and international linkages, was asked.</td>
</tr>
<tr>
<td>7119</td>
<td>64</td>
<td>41</td>
<td>64</td>
<td>41</td>
<td>What is the difference between section 4.4.6.1 and section 4.4.6.2? Section 4.4.6.2 is basically about ICTs, so the authors may consider a new title for the section. [Elisa Mata, Sweden]</td>
<td>Taken into account. Accepted. A case study onaviour in Brazil, adressing both innovation and international linkages, was asked.</td>
</tr>
</tbody>
</table>
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---

7119 | 64 | 45 | 65 | 45 | Innovations in nuclear power should also be mentioned here. Reactors based on a thorium fuel cycle, or a S PCIIC cycle that takes LWR fuel and puts them into HWR (like a Candu reactor) which drastically reduces nuclear fuel use. Innovations in molten salt reactors and small modular reactors (SMR) could drastically change the landscape of the energy sector in a very positive way. For example, molten salt reactors would be able to burn current nuclear waste and get dozens of times the electricity out. These innovations should be explored and addressed here. This report has assembled an impressive array of expertise, but the specifics of the nuclear power industry are not well represented, this could be remedied by having an author specifically for nuclear power. [Jason Donen, Canada]. Taken into account. Nuclear power feasibility is addressed in 4.3.2. |

6716 | 64 | 46 | 65 | 46 | Solar is also outperforming new fossil fuel power stations in less sunny parts of the world. https://towardsdatascience.com/sea-the-year-solar-panels-finally-became-cheaper-than-fossil-fuel-jul-2017/2017/5/29/5eae8b68b6394fca89143a8d4f972b93f (57 megawatts a day for £40,000). What has an increase in robotics and AI meant and will continue to mean for the workforce? What will happen to all the people who are displaced as a result of this innovation? Will this line still be meaningful when this sector shifts away from using gigawatts to terawatts? What will be the impact of this on the workforce? What will happen to all the people who are displaced as a result of this innovation? | Taken into account. These aspects are covered in section 4.3.2 as well as 4.5.3. |

777 | 64 | 54 | 66 | 54 | Missing from this paragraph is the home battery systems from the lines of Tesla, Moos and many more. Home battery systems have become a large market. [Ricoh Kim, United Kingdom (of Great Britain and Northern Ireland)]. Noted, partly addressed in 4.3.2 but there was no space, not literature provided, to address this specifically here. |

4268 | 64 | 56 | 65 | 56 | Note: WE have accounted for horizon costs of technology as unaccountable resource extraction, waste disposal, etc. [Kai Loest, United States of America]. Taken into account. These aspects are covered in the feasibility assessment in 4.3. |

6220 | 64 | 47 | 64 | 53 | Lakeshade, Erick, Robert MacNeil, and Matthew Paterson. 2018. The Political Economy of Decarbonisation. From Green Energy Race to Green ‘Division of Labour’. New Political Economy 23:21-37. would be useful on the claim here. That article explicitly analyzes the interaction between R&D policies (especially in the US), labour/industrial strategies (especially China) and installation policies (such as feed in tariffs) in places like Germany. [Matthew Paterson, United Kingdom (of Great Britain and Northern Ireland)]. Accepted. Reference added. |

18573 | 64 | 51 | 65 | 51 | Netzt 2014 needs a Mendeley link (https://www.energynet.de/2014/10/24/netzt-2014-deutschland/) | Accepted link added. |

570 | 64 | 52 | 65 | 52 | Specific large-scale users and buyers can understand the average price of battery, “if you add that to the price of the battery, you can compare it to the number of potential for PV given a few lines earlier”. McKinsey indicates a price of $277 USD per kWh (https://www.mckinsey.com/~/media/mckinsey/industries/energy-resource/insights/evolution-of-electric-vehicles/mck-innovation-is-key-to-electric-vehicle-success.ashx). The LCOE for new wind ranges from $32 to $92 per MW, new solar PV- thin film utility scale from $46 to $56 per MW and new wind combined cycle from $45 to $78 per MW. https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf. [Jennifer Morgen, Netherlands]. Taken into account. |


4194 | 65 | 2 | 65 | 14 | What happens if the high in economics and AI mean and will continue to mean for the workforce? What will happen to all the people who are displaced as a result of this innovation? Will this line still be meaningful when this sector shifts away from using gigawatts to terawatts? | Rejected. It is a valuable point but the assessment of GPTs is beyond the scope of this report. |

1027 | 65 | 2 | 65 | 14 | Sharing economy from ownership to sharing (as, e-scooters) in combination with AI & IV may have huge potential to save energy, though not intending to reduce emissions. It would be better to add these new behavioral change that has no relationship with climate change, still have a huge impact on climate change. [Michele Levi, Canada]. Taken into account in various places in this section, in section 4.4.3 (behavioural change). |

13075 | 65 | 4 | 65 | 4 | IEA 2017 needs a Mendeley link (https://www.energynet.de/2017/7/11/iea-2017) | Accepted link added. |
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>6599</td>
<td>65</td>
<td>10</td>
<td>65</td>
<td>14</td>
<td>Consider to mention the global growth of e-waste and energy consumption derived from ICT production and running and e-waste treatment and its impact on global ecosystems resilience. [J. David Tabara, Spain]</td>
<td>Accepted. Resource-use of ICT vs by ICT discussed in text</td>
</tr>
<tr>
<td>7225</td>
<td>65</td>
<td>11</td>
<td>65</td>
<td>11</td>
<td>insert after ‘...AI,...’ Additive Manufacturing [Leendert Verhoef, Netherlands]</td>
<td>Taken into account. Not added here but listed in Table 4.7</td>
</tr>
<tr>
<td>14407</td>
<td>65</td>
<td>14</td>
<td>65</td>
<td>15</td>
<td>Leendert et al. 2010 needs a Mendeley link [Wilfried Mouldouka Ofah, France]</td>
<td>Accepted. Thanks added to the literature in the final draft.</td>
</tr>
<tr>
<td>18578</td>
<td>65</td>
<td>17</td>
<td>65</td>
<td>50</td>
<td>Section 4.4.2 needs a Mendeley link [Wilfried Mouldouka Ofah, France]</td>
<td>Accepted. Reference added.</td>
</tr>
<tr>
<td>7920</td>
<td>65</td>
<td>17</td>
<td>65</td>
<td>51</td>
<td>The section does not mention AVs, which may or may not reduce emissions. AVs could increase transport efficiency, but actually lead to higher car ownership and result in greener congestion. They could be useful for parking and allowed urban cores, but could also contribute to private real estate.</td>
<td>Taken into account. The ambiguous contribution to mitigation, and lack of reference for 1.5C, means that it’s not mentioned here.</td>
</tr>
<tr>
<td>14107</td>
<td>65</td>
<td>18</td>
<td>65</td>
<td>18</td>
<td>The term ‘contingency as planned’ should not be misused. [Elvira Poloczanska, Germany]</td>
<td>Accepted. Text removed.</td>
</tr>
<tr>
<td>14106</td>
<td>65</td>
<td>19</td>
<td>65</td>
<td>19</td>
<td>The reference to complex systems theory is not clear here. The complexity theory to be utilised in this section, with key elements such as emergence, uncertainty/uncertainty, and feedbacks regarding technological change need to be addressed. Otherwise, I suggest to remove this reference. [Elvira Poloczanska, United States of America]</td>
<td>Accepted. Text removed.</td>
</tr>
<tr>
<td>14108</td>
<td>65</td>
<td>22</td>
<td>65</td>
<td>22</td>
<td>For updating [Elvira Poloczanska, Germany]</td>
<td>Taken into account, text removed.</td>
</tr>
<tr>
<td>7322</td>
<td>65</td>
<td>29</td>
<td>65</td>
<td>32</td>
<td>If the options were presented here in a schematic way. [Erika Mata, Sweden]</td>
<td>Accepted. Table added to take care of this.</td>
</tr>
<tr>
<td>14109</td>
<td>65</td>
<td>31</td>
<td>65</td>
<td>32</td>
<td>Stable ‘care should be taken’ – it is misleading. Giving meaning that care should be taken to make rebound effects as large as emission cuts! [Elvira Poloczanska, Germany]</td>
<td>Accepted. Text modified to focus on the solution rather than the problem.</td>
</tr>
<tr>
<td>11185</td>
<td>66</td>
<td>36</td>
<td>66</td>
<td>37</td>
<td>as ambitious mitigation policy might undermine economic progress if inadequately implemented – climate change impacts may also undermine economic progress, as might other policy agendas or even mitigation policy (e.g. by bringing the climate change risk to be a first mover).</td>
<td>Accepted. Text removed.</td>
</tr>
<tr>
<td>3034</td>
<td>66</td>
<td>41</td>
<td>66</td>
<td>42</td>
<td>‘Theor 2017’ and ‘Frame 2017’ are missing from references [Stewart Reavey, Canada]</td>
<td>Accepted. Added.</td>
</tr>
<tr>
<td>7121</td>
<td>66</td>
<td>54</td>
<td>66</td>
<td>54</td>
<td>The authors may consider a change in the title to summarise the key measure of the section, e.g. ‘innovation policy is needed to provide 1.5C- necessary ambition’.</td>
<td>Accepted. IPC cannot be policy prescriptive. However, we do discuss the relevance of innovation policy.</td>
</tr>
<tr>
<td>4195</td>
<td>66</td>
<td>1</td>
<td>66</td>
<td>6</td>
<td>CTC-N launched Mission Innovation, but it is yet to be made clear as to how and what initiatives will get funding. What will the thresholds be for climate mitigation and adaptation in order to receive funding and sell all technologies be considered if they meet the requirements. [Michelle Leslie, Canada]</td>
<td>Accepted. No action required. It seems...</td>
</tr>
<tr>
<td>15004</td>
<td>66</td>
<td>6</td>
<td>66</td>
<td>6</td>
<td>White there is still this information to know what the authors intend to include in this section. In this light there have been many calls for increasing R&amp;D funding. “They should be used in the objective and policy neutrality. [Ferhat Akhtar, United States of America]</td>
<td>Accepted. Sentences removed.</td>
</tr>
<tr>
<td>15005</td>
<td>66</td>
<td>4</td>
<td>66</td>
<td>6</td>
<td>Mission innovation reference should be ‘seek to double’ not ‘committed to double’ [Ferhat Akhtar, United States of America]</td>
<td>Accepted. Text modified as suggested.</td>
</tr>
<tr>
<td>3003</td>
<td>66</td>
<td>4</td>
<td>66</td>
<td>7</td>
<td>The author failed to mention the UNFCCC-backed new ‘Climate Technology Centre and Network’ which is central to the international response to technological challenges, development and deployment. Its mission is to develop, transfer and to aid developing countries to develop and adaptation technologies, in a recipient country-driven framework, under which every entity in a developing country (both governmental and non-governmental) can ask the National Focal Point to be prioritized for support. The UNFCCC, however, encourages the country to be included as a recipient country for which they will be eligible for the National Determined Contribution and sustainable development strategies. If so, CTC-N is contacted and a Terms of Reference for a competitive bid across world-class institutes and solution providers is carried out, with no restriction to the recipient country, as no costs for them. The financial spoils and the increase in the ambition of the requested technologies (with more emphasis on development and not only on transfer of existing technologies) would make the CTC-N a central actor for the international response to limiting warming to 1.5°C. See more at <a href="https://www.ctc-n.org">https://www.ctc-n.org</a></td>
<td>Accepted. Text modified and CTC-N and Breakthrough Energy Coalition referred.</td>
</tr>
<tr>
<td>1220</td>
<td>66</td>
<td>8</td>
<td>66</td>
<td>8</td>
<td>CTC does not discuss climate-related pathways but ‘climate-related development pathways’ (5.1. and 5.7). Remove a reference to CTS here. [Petra Tikkanen, Australia]</td>
<td>Accepted. Reference removed.</td>
</tr>
<tr>
<td>18579</td>
<td>66</td>
<td>8</td>
<td>66</td>
<td>8</td>
<td>IPCC WG3 2014 Ch. 15. GEA 2012 needs a Mendeley link [Wilfried Mouldouka Ofah, France]</td>
<td>Accepted. Text linked.</td>
</tr>
<tr>
<td>5348</td>
<td>66</td>
<td>10</td>
<td>66</td>
<td>10</td>
<td>The statement ‘Governments have employed a rather novel and may be continued as ‘including those that may be characterized as containing features of a sustainability-oriented innovation system’ [St Kljuaj, Turkey]</td>
<td>Accepted. Text was changed as a result of editing and other comments. In any case, more text is added on governmental innovation policy.</td>
</tr>
<tr>
<td>7352</td>
<td>66</td>
<td>10</td>
<td>66</td>
<td>10</td>
<td>Delete the text ‘innovation’ [Eleni Kaditi, Austria]</td>
<td>Rejected. We are talking about innovation policy. Not policy in general.</td>
</tr>
<tr>
<td>14580</td>
<td>66</td>
<td>13</td>
<td>66</td>
<td>13</td>
<td>Delete the text ‘revenues for R&amp;D could come from the general budget, but could also be generated by carbon pricing schemes’ (see also section 4.4.7) or, for instance, energy or resource taxation [Eleni Kaditi, Austria]</td>
<td>Rejected. The text is modified to make the meaning of carbon pricing clearer.</td>
</tr>
</tbody>
</table>
| 7122       | 66        | 11        | 66      | 11      | Section 4.4.6.4 only seems to argue that technology is necessary. Such a justification may fit better as the first subsection of 4.4.6 rather than the last, or, for instance, energy or resource taxation. "Like biological ecosystems, technology systems evolve over time by combining existing characteristics as containing features of a sustainability-oriented innovation system." [Siir KILKIS, Turkey] | Accepted. The point here is important and has a literature base. However, the text is modified to...

---

Page 132 of 159

Do Not Quote, Cite, or Distribute
There are multiple references to technology transfer or references to technology in the Convention and the Paris Agreement that are incorrect or misleading. Replace “technology transfer and innovation” with “enhanced action in technology transfer and deployment” when referring to PA or, generally, use “technology” or “technology innovation, deployment, diffusion, and transfer.” Also, should not refer specific articles of the Convention (line 18), and reference to TNAs in line 49-49 is one selective component of the PA (Faran Ailane, United States of America)  

Acceptor (the first half of comment): text modified on the wording regarding technology and innovation.  

Rejected (the second half of comment) reference to relevant part of UNFCCC is necessary here.

15006 05 17 06 51  

18581 05 18 06 18  

15852 05 22 02 22  

15007 05 22 06 22  

941 05 26 06 26  

15008 06 31 06 31  

18583 06 38 06 40  

10902 05 39 06 43  

5237 06 54 07 2 

3698 07 7  

7393 07 11 07 17  

778 07 15 07 15  

17684 07 15 07 15  

14101 08 15 08 17  

19758 07 15 07 15  

7396 07 15 07 22  

7921 07 24 07 24  

13076 07 23 07 23  

11193 07 23 07 27  

4903 07 24 07 24  

Do Not Quote, Cite, or Distribute Page 133 of 159  

Chapter 4
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
3699 | 67 | 26 | 67 | 37 | Good discussion of energy transitions. Consider adding a point that the relative prices of renewable energy compared to fossil fuels (esp for electricity generation) have decreased dramatically in the last few years. New wind is now cheaper (in $/MW installed capacity) than new coal in many countries. That means there is no 'incremental cost' to mitigation in the respect. Much literature: e.g. recently - OECD (Organisation for Economic Co-operation and Development) 2017. Investing in climate, investing in growth. http://www.oecd.org/environment/investing-in-climate-investing-in-growth-9789264237358-en.htm. and as well IRENA REMAP reports [Harald Winkler, South Africa] | Accepted - will clarify the links between cost of specific techniques, marginal cost of a system and welfare cost. The cut-in-some technological segments does not translate proportionally into cuts for the system and for the society
14292 | 67 | 30 | 67 | 31 | The German energy transition is taking no-emission nuclear out of the grid in favour of renewables, it's important and burning coal to do this. | Rejected - We do not say that this is a success story, we simply say this led to higher consumer prices in Germany (Not Europe as it says now. JC makes changes)
14393 | 67 | 30 | 67 | 31 | The prices are an interesting story... can I see it? [Jason Done, Canada] | Accepted - we will add a reference.
3092 | 67 | 30 | 67 | 32 | weird comma placement after "transition" [Christopher Bataille, Canada] | Accepted, change made.
779 | 67 | 38 | 67 | 38 | Wider line margin than usual paragraph [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)] | Editorial - take into account and text will be modified accordingly
1918 | 67 | 39 | 67 | 48 | I would suggest inserting a paragraph on the distributions of non-marketed benefits of climate change mitigation and (renewable energy policy). | Accepted - will insert the reference
14136 | 67 | 43 | 67 | 43 | Formatting needed for these citations [Enriva Poloczanska, Germany] | Accepted, change made.
18569 | 67 | 43 | 67 | 43 | I would suggest inserting a paragraph on the distributions of non-marketed benefits of climate change mitigation and renewable energy policy. | Accepted, change made.
750 | 67 | 44 | 67 | 44 | Problem with citation formatting [Blake Kim, United Kingdom (of Great Britain and Northern Ireland)] | Accepted, change made.
10091 | 67 | 49 | See Reference et al., 2018 (In Press) for equity issues [Cynthia Rosenzweig, United States of America] | Accepted - reference added
3093 | 67 | 50 | 68 | 6 | Some authors make a strong case for environmental improvements that mandate pratically infeasible transfers, leading to differential carbon prices by jurisdiction depending on the social welfare function. | Accepted, good point. We can insert the discussion.
18379 | 67 | 53 | 67 | 53 | TSI needs a copy of Demelly et al. (2019) - please check which report is referred to. Is it this one? http://www.idb.org/Events/Interventions/Intervention2/07822_workshopberlin_Competitiveness_slemr_report.pdf [Wilfran Moufouma Okia, France] | Accepted - we will insert the reference
18566 | 68 | 4 | 68 | 4 | Barger et al. 2016 needs a Mendeley link [Wilfran Moufouma Okia, France] | Accepted, change made.
18567 | 68 | 10 | 68 | 10 | Priller et al. 2019 needs a Mendeley link [Wilfran Moufouma Okia, France] | Accepted, change made.
3700 | 68 | 13 | 68 | 13 | the case for pricing carbon differently might be a link to a key developmental goal, namely poverty eradication. One mechanism would be to use the revenues from carbon pricing to fund reduction in poverty. | Taken into account - but this will be inserted in the next section.
18568 | 68 | 14 | 68 | 14 | Jacob and Hlare 2015; McGlade and Ekins 2015 need Mendeley links [Wilfran Moufouma Okia, France] | Accepted, change made.
18569 | 68 | 19 | 68 | 19 | IPCC TAR, AR4 and AR5 need Mendeley links [Wilfran Moufouma Okia, France] | Accepted, change made.
Market mechanisms like the Clean Development Mechanism (CDM) can be an important element of the toolbox to reach a 1.5°C target. There is ample literature to show that the CDM has massively mobilized mitigation in developing countries and reduced mitigation cost. I suggest to add the following text after the line 24: “Market mechanisms for mitigation like the Clean Development Mechanism under the Kyoto Protocol are crucial to mobilize low-cost mitigation (Camerlenghi and Minx 2016). The CDM has been instrumental in mobilizing mitigation in developing countries, especially from renewable energy (see overview of CDM-related literature in Michaelowa 2015, Steiner et al. 2014, and specific country studies, e.g. for China: Lewis 2010). After initial teething troubles, the rubric for determination of project additionality has been improved, so the mitigation contribution of projects became more robust (Michaelowa 2009). If demand of emission credits increased in the future, market mechanisms like the CDM could play an important role in reducing mitigation cost, thus leading to further mitigation and an increased BAU pathway to reach the 1.5°C target of the Paris Agreement (Bordona et al. 2017).”


taken into account - covered in section 4.4.2.2.
Do Not Quote, Cite, or Distribute Page 136 of 159
Bataille et al. (2016) needs a Mendeley link [Wilfran Moufouma Okia, France]


Editorial.

Bataille, Canada]

Achieving development and mitigation objectives through a decarbonization development pathway in South Africa, Climate Policy, 16:sup1, S78-S91, DOI: http://dx.doi.org/10.1080/14693062.2016.1173005 [Christopher Bataille, Canada]

Reference for Bataille et al. 2016 missing from the reference list. There are two: the first is a special issue editorial, the second a synthesis article - I suspect the reference is for the latter syntheses article. Batelle, C., H. Waisman, M. Colombier, L. Segafredo, J. Williams & F. Jotzo (2016) The need for national deep decarbonization pathways for effective climate policy, Climate Policy, 16(sup1), 57-62, DOI: http://dx.doi.org/10.1080/14693062.2016.1173009 [Christopher Bataille, Canada]

Reference missing for Bataille et al. 2016. This is a special issue editorial. [Christopher Bataille, Canada]

This sentence appears to be incomplete [Alison Smith, United Kingdom (of Great Britain and Northern Ireland)] Accepted - "But" changed to "However"

Altieri et al, 2016 needs a Mendeley link [Wilfran Moufouma Okia, France]

Do Not Quote, Cite, or Distribute Page 137 of 159

Do Not Quote, Cite, or Distribute Page 137 of 159

Of interest might also be the consequences of nuclear phase out and replacing nuclear power plants with coal, see for example a study published in [钬cvident for energy security policies in Japan. Climate Policy, 16(sup1). doi: 10.1080/14693062.2016.1155042 [Christopher Bataille, Canada]

Research missing for Oshiro et al. 2016. [Christopher Bataille, Canada]

Thomas Longden, Australia

Spencer under review needs a Mendeley link [Wilfran Moufouma Okia, France]

References required to be added to the reference list for Mathy et al. 2016. [Christopher Bataille, Canada]

Mathy et al. 2016 needs a Mendeley link [Wilfran Moufouma Okia, France]

Editors.

Noted - however, the German Energy Transition is only serving as an example here for sustaining a policy despite changing objectives. No claim is made with respect to the cost of the policy or its success in reducing emissions.

Altieri et al, 2016 needs a Mendeley link [Wilfran Moufouma Okia, France]

Spencer under review needs a Mendeley link [Wilfran Moufouma Okia, France]

This is surprising to see Germany taken as an example, given the complex failure of the Energiewende, since both the nuclear and fossil energy phase out have stalled far from completion. Nuclear power is still used in Germany, because closing the remaining 9.8 GW of nuclear power plants would create a CO2 emissions jump of over 20 million tons of CO2 per year. Furthermore, emissions have not been decreasing for the past 9 years. Therefore, taking Germany as an example is both a misrepresentation of reality, and a factor of risk for related policy makers. In fact, Germany's flexibility to adjust to new objectives is just hiding the fact that renewable substances are not helpful for deep decarbonization pathways, in fact, experience shows that reducing GHG emissions in industrialized countries requires aggressive CO2/GHG pricing (because Exchange and Trading Systems are much too slow or can be blocked by governments) [Stephan Sassevere, France]
It is already apparent that the German transition has severe difficulties since the very expansive development of intermittent renewable electricity has not resulted in a significant reduction of CO2 emissions. In 2007, the ratio of CO2/PES was 2.38 for Germany (1.41 for France) while in 2016 the ratio of CO2/PES was 2.18 for Germany while that of France decreased to 1.8. Using the indicator CO2/pop the 2007 value was 9.87 for Germany and 6.19 for France while, for 2016, it was 8.53 for Germany and 4.32 for France. The decrease was 9% for Germany and 30% for France [Henne Nilecke, France]

If the claim is being made that ‘renewable energy’ has made, or even will make, Germany’s GHG emissions go down, then that needs to be cited. I don’t believe that they actually reduced their emissions in any real way. [Jason Dow, Canada]

The OECD “Investing in climate, investing in growth” report could be cited here, with their findings that investing in climate resilient growth would only add 10% (infrastructure needs over the next 15 years) [Michel Schaeffer, Netherlands]

The OECD report should mention as lessons of market mechanisms stated in the Study prepared for DG UMA of European Commission, https://ec.europa.eu/clima/policies/flexibility/doc/key_mechanism_en.pdf. That is the COM still has fundamental flaws in terms of overall environmental integrity. [Yuji Mizuno, Japan]

The work by the New Climate Economy and OECD are relatively small. For instance, the work by the New Climate Economy and OECD. [Farhan Akhtar, United States of America]

Even if the Ombudsman’s report was in 2015, it is reasonable to use it as a baseline when discussing the development of the 4° path. [Farhan Akhtar, United States of America]

There are a few other points to bring up here. [Farhan Akhtar, United States of America]

Section on Climate Finance: Development requires energy but not carbon emissions. The right to development of people in developing countries requires that they have access to alternative sources of energy to develop and lift themselves out of poverty. It is unreasonable to expect developing countries to be a significant element in accelerating the required transition. The chapter could e.g. quote and discuss reports which investigated the potential revenues that could be raised through instruments such as taxes on international aviation and maritime transport, carbon major’s levy etc., see e.g.: Durand, A et al., 2016: Financing Options for Loss and Damage: a Review and Roadmap or others [Sven Harmeling, Germany]

The notion of incremental costs is not relevant in a below 2°c world because the first priority is to reduce the funding gap for low-carbon, climate resilient infrastructures in many developing countries. [Michel Schaeffer, Netherlands]

The quote of the chapter’s title is incorrect. [Sven Harmeling, Germany]

Some parts of the finance section are difficult for a non-finance expert to understand. e.g. “The notion of incremental costs is not relevant in a below 2°c world because the first priority is to reduce the funding gap for low-carbon, climate resilient infrastructures in many developing countries.” [Michel Schaeffer, Netherlands]

Use US$ currency format [Radim Tolasz, Czech Republic]

The report should mention as lessons of market mechanisms stated in the Study prepared for DG UMA of European Commission, https://ec.europa.eu/clima/policies/flexibility/doc/key_mechanism_en.pdf. That is the COM still has fundamental flaws in terms of overall environmental integrity. [Yuji Mizuno, Japan]

Taken into account

The chapter misses out almost completely on aspects related to the EU climate finance architecture and related discussions to generate financial flows to assist climate action (in particular in developing countries) at the scale of hundreds of billions, which could be a significant element in accelerating the required transition. The chapter could e.g. quote and discuss reports which investigated the potential revenues that could be raised through instruments such as taxes on international aviation and maritime transport, carbon major’s levy etc., see e.g.: Durand, A et al., 2016: Financing Options for Loss and Damage: a Review and Roadmap, or others [Sven Harmeling, Germany]

Entire chapter “climate finance” the chapter misses out almost completely on aspects related to the EU climate finance architecture and related discussions to generate financial flows to assist climate action (in particular in developing countries) at the scale of hundreds of billions, which could be a significant element in accelerating the required transition. The chapter could e.g. quote and discuss reports which investigated the potential revenues that could be raised through instruments such as taxes on international aviation and maritime transport, carbon major’s levy etc., see e.g.: Durand, A et al., 2016: Financing Options for Loss and Damage: a Review and Roadmap, or others [Sven Harmeling, Germany]

Taken into account below the line

It is already apparent that the German transition has severe difficulties since the very expansive development of intermittent renewable electricity has not resulted in a significant reduction of CO2 emissions. In 2007, the ratio of CO2/PES was 2.38 for Germany (1.41 for France) while in 2016 the ratio of CO2/PES was 2.18 for Germany while that of France decreased to 1.8. Using the indicator CO2/pop the 2007 value was 9.87 for Germany and 6.19 for France while, for 2016, it was 8.53 for Germany and 4.32 for France. The decrease was 9% for Germany and 30% for France [Henne Nilecke, France]

If the claim is being made that ‘renewable energy’ has made, or even will make, Germany’s GHG emissions go down, then that needs to be cited. I don’t believe that they actually reduced their emissions in any real way. [Jason Dow, Canada]

The OECD “Investing in climate, investing in growth” report could be cited here, with their findings that investing in climate resilient growth would only add 10% (infrastructure needs over the next 15 years) [Michel Schaeffer, Netherlands]

The report should mention as lessons of market mechanisms stated in the Study prepared for DG UMA of European Commission, https://ec.europa.eu/clima/policies/flexibility/doc/key_mechanism_en.pdf. That is the COM still has fundamental flaws in terms of overall environmental integrity. [Yuji Mizuno, Japan]

Use US$ currency format [Radim Tolasz, Czech Republic]

The report should mention as lessons of market mechanisms stated in the Study prepared for DG UMA of European Commission, https://ec.europa.eu/clima/policies/flexibility/doc/key_mechanism_en.pdf. That is the COM still has fundamental flaws in terms of overall environmental integrity. [Yuji Mizuno, Japan]

Use US$ currency format [Radim Tolasz, Czech Republic]
IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4

<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>20325</td>
<td>75</td>
<td>24</td>
<td>75</td>
<td>24</td>
<td>Which sectors are included under infrastructure? [Marx Gomez, France]</td>
</tr>
<tr>
<td>2756</td>
<td>75</td>
<td>24</td>
<td>75</td>
<td>26</td>
<td>These figures do not appear to include the necessary adaptation costs - it would be important to include these. [Pennie Ungurath, South Africa]</td>
</tr>
<tr>
<td>18787</td>
<td>75</td>
<td>25</td>
<td>75</td>
<td>26</td>
<td>The reference to the report by the Global Commission on Economy &amp; Climate, Better Growth, Better Climate, misconstrues the findings. The report finds that approx. $90 trillion in infrastructure spending is needed globally from 2015-2030, but that is not specifically low-carbon investment. It calculates that only an additional $4 trillion is required to make those infrastructures investments compatible with low-carbon pathways, even before accounting for savings from fixed fuel-use reduction (see, for example, page 39 of the 'global report' version of the report). [David Kwanlok, United States of America]</td>
</tr>
<tr>
<td>18820</td>
<td>75</td>
<td>25</td>
<td>75</td>
<td>26</td>
<td>The reference to the report by the Global Commission on Economy &amp; Climate, Better Growth, Better Climate, misconstrues the findings. The report finds that approx. $90 trillion in infrastructure spending is needed globally from 2015-2030, but that is not specifically low-carbon investment. It calculates that only an additional $4 trillion is required to make those infrastructures investments compatible with low-carbon pathways, even before accounting for savings from fixed fuel-use reduction (see, for example, page 39 of the 'global report' version of the report). [David Kwanlok, United States of America]</td>
</tr>
<tr>
<td>4202</td>
<td>75</td>
<td>28</td>
<td>75</td>
<td>32</td>
<td>Use US$ currency format [Radim Tolasz, Czech Republic] Accepted</td>
</tr>
<tr>
<td>4203</td>
<td>75</td>
<td>28</td>
<td>75</td>
<td>33</td>
<td>Use US$ currency format [Radim Tolasz, Czech Republic] Accepted</td>
</tr>
<tr>
<td>18619</td>
<td>75</td>
<td>28</td>
<td>75</td>
<td>33</td>
<td>Wolf et al. 2017 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted</td>
</tr>
<tr>
<td>4204</td>
<td>75</td>
<td>30</td>
<td>75</td>
<td>33</td>
<td>Use US$ currency format [Radim Tolasz, Czech Republic] Accepted</td>
</tr>
<tr>
<td>1900</td>
<td>75</td>
<td>40</td>
<td>75</td>
<td>40</td>
<td>I don't understand - climate models do not estimate financial flows. What does the sentence mean? If referring to integrated assessment models, say so and make clear that these are no climate models (though they may have a climate change component). [Michael MacCracken, United States of America] Accepted - we will correct it</td>
</tr>
<tr>
<td>16447</td>
<td>75</td>
<td>50</td>
<td>75</td>
<td>50</td>
<td>Use US$ currency format [Radim Tolasz, Czech Republic] Accepted</td>
</tr>
<tr>
<td>17241</td>
<td>75</td>
<td>50</td>
<td>75</td>
<td>50</td>
<td>Isn't the reference enough to make it seem to be significant? [Fatemeh Gahpe, India] Editorial</td>
</tr>
<tr>
<td>9901</td>
<td>75</td>
<td>50</td>
<td>75</td>
<td>50</td>
<td>There is a missing word &quot;for&quot; in the phrase &quot;want to say more significant&quot; [Pier Klim, Germany] Editorial</td>
</tr>
<tr>
<td>3105</td>
<td>75</td>
<td>50</td>
<td>75</td>
<td>52</td>
<td>These figures: the reference could be more clear. [Jasper Meya, Germany] Taken into account</td>
</tr>
<tr>
<td>3106</td>
<td>75</td>
<td>50</td>
<td>75</td>
<td>60</td>
<td>Whole paragraph needs more context and elaboration. If the media got a hold of this as it is it would be extremely easy to misinterpret. [Christopher Bartalle, Canada] Taken into account - we will rewrite</td>
</tr>
<tr>
<td>18820</td>
<td>75</td>
<td>54</td>
<td>75</td>
<td>54</td>
<td>Africk Aglietta et al. into grey shaded Mendeley field with &quot;2017&quot; [Wilfran Moufouma Okia, France] Accepted</td>
</tr>
<tr>
<td>17530</td>
<td>76</td>
<td>1</td>
<td>76</td>
<td>10</td>
<td>Not clear why notion of incremental &quot;costs&quot; are relevant in a below 2deg scenario. Could be clarified further. [Farnam Ahmar, United States of America] Accepted - there was totally unclear sentence</td>
</tr>
<tr>
<td>3107</td>
<td>76</td>
<td>13</td>
<td>76</td>
<td>13</td>
<td>Attention to [Christopher Bartalle, Canada] Editorial</td>
</tr>
<tr>
<td>18620</td>
<td>76</td>
<td>13</td>
<td>76</td>
<td>23</td>
<td>Africk Aglietta et al. into grey shaded Mendeley field with &quot;2017&quot; [Wilfran Moufouma Okia, France] Accepted</td>
</tr>
<tr>
<td>18623</td>
<td>76</td>
<td>22</td>
<td>76</td>
<td>23</td>
<td>Article 173 in the 2015 Energy Transition Law needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted</td>
</tr>
<tr>
<td>18627</td>
<td>76</td>
<td>38</td>
<td>76</td>
<td>38</td>
<td>Kelly and others (2018) in the UK report on Environmental infrastructure investment in the UK. [Wilfran Moufouma Okia, France] Accepted - we will include the reference</td>
</tr>
<tr>
<td>10257</td>
<td>76</td>
<td>39</td>
<td>76</td>
<td>43</td>
<td>Ethical investment, that has been around for a decade, offers one path. [Mendas Zrinka, United Kingdom (of Great Britain and Northern Ireland)] Accepted - we will address</td>
</tr>
<tr>
<td>7362</td>
<td>76</td>
<td>39</td>
<td>76</td>
<td>43</td>
<td>Delete the text &quot;The voluntary disclosure approach may be a first step to encourage financial actors to stop investing in fossil fuels (Ayling and Cornish, 2015)” [Michael MacCracken, United States of America] Accepted - we will address the issue of disclosure and investment in fossil fuels.</td>
</tr>
<tr>
<td>7925</td>
<td>76</td>
<td>40</td>
<td>76</td>
<td>63</td>
<td>Climate finance leverage ratios. It would be good to cite more recent literature. The average leverage ratios may be too high for climate finance at least. See the latest MDB Joint Report on Climate Finance (2016). MDBs committed US$ 27.48 in climate finance in 2016. Private sector co-financing was US$ 15.78. [Stephen Michael, United States of America] Accepted - very good point. We will place more attention on articulation between domestic and international climate finance. James will give some text on adaptation.</td>
</tr>
<tr>
<td>18624</td>
<td>76</td>
<td>41</td>
<td>76</td>
<td>51</td>
<td>In-text citation for Berke and Meanci. Rose 2005 has one uncited references also linked (Jalco, Xiong) [Wilfran Moufouma Okia, France] Accepted</td>
</tr>
<tr>
<td>18625</td>
<td>76</td>
<td>53</td>
<td>76</td>
<td>53</td>
<td>Aglietta F, Proust S, and others 2017 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted</td>
</tr>
<tr>
<td>18627</td>
<td>77</td>
<td>9</td>
<td>77</td>
<td>13</td>
<td>Studer &amp; Gallagher, 2015; Erino et al. need a Mendeley link [Wilfran Moufouma Okia, France] Accepted</td>
</tr>
<tr>
<td>18378</td>
<td>77</td>
<td>12</td>
<td>77</td>
<td>13</td>
<td>BTS needs a copy of the de Gruykowski and Zeller report - hard to find [Wilfran Moufouma Okia, France] Accepted</td>
</tr>
</tbody>
</table>
This section is fundamental to the report, but it looks incomplete and fragmented. You need to consolidate it better.

Rajan 2016 needs a Mendeley link

Rozengerg et al., 2013 needs a Mendeley link

Safarzynskya and Van den Bergh, 2017 needs a Mendeley link

Delete the text "which may need overseas development assistance, innovative removal of fossil fuel subsidies (Jakob 2016) and introduction of carbon..." NCE 2016 needs a Mendeley link

Venables 2016; Ross 2015 need a Mendeley link

Move "Hirth and Steckel (2016)" into grey shaded Mendeley field with "2016"
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
7095 | 78 | 36 | 80 | 11 | Livens (2017, 2018) sketches a thought-experiment, in course of submission to Science, that this section could usefully reflect: two exceptionally detailed,iggins, and empirically grounded syntheses—the on-track US (Lovins & RWW 2011) and officially adopted Chinese (ERI 2017) Reinventing Fire studies, both summarized in my comments on Ch 4 x 14-16—-a plan of an analogous early ex study (European Climate Foundation 2010), can be extrapolated to the world by using the US as a surrogate for other non-EU OECD countries and China for non-OECD countries. Promoting on those categories: EX-projected GDPs (extended from 2040 to 2050) then suggests the world could achieve a ~2 C global climate trajectory, providing the same energy services as business-as-usual, at a ~$18 trillion lower net present value private internal cost. Partial reinvestment in natural systems: carbon removal—biologically informed farming, forestry, grazing, wetlands and rainforest management, etc. (e.g. Griscom et al. 2017, Abrahams et al. 2017—could then probably achieve a ~1.5 C trajectory, with trillions of dollars left over. Of course, the global extrapolation could be conservative or unconvincing in different countries, especially with regard to potential adoption lags in some and the accelerating pace of renewable power adoption in many (e.g. Creutzig et al. 2017). But though speculative at the global scale, the analytic basis is sufficiently solid and aligned with actual progress for half the world that the global extrapolation offers both hope and a worthy direction to consider. (Livens 2017) points out that though these analyses do not use complex models except for simulating power-grid integration (where they used the best available models), their simple engineering-economic methodologies have shown superior predictive power both over the past 40 years and since these specific US and Chinese Reinventing Fire studies were published. 

[Amory Lovins, United States of America] | Noted - but beyond the scope of the section and not whether the expected submission might be in the scope of eq. 4.4.6.

7533 | 78 | 36 | 80 | 11 | Livens (2017, 2018) sketches a thought-experiment, in course of submission to Science, that this section could usefully reflect: two exceptionally detailed,iggins, and empirically grounded syntheses—the on-track US (Lovins & RWW 2011) and officially adopted Chinese (ERI 2017) Reinventing Fire studies, both summarized in my comments on Ch 4 x 14-16—-a plan of an analogous early ex study (European Climate Foundation 2010), can be extrapolated to the world by using the US as a surrogate for other non-EU OECD countries and China for non-OECD countries. Promoting on those categories: EX-projected GDPs (extended from 2040 to 2050) then suggests the world could achieve a ~2 C global climate trajectory, providing the same energy services as business-as-usual, at a ~$18 trillion lower net present value private internal cost. Partial reinvestment in natural systems: carbon removal—biologically informed farming, forestry, grazing, wetlands and rainforest management, etc. (e.g. Griscom et al. 2017, Abrahams et al. 2017—could then probably achieve a ~1.5 C trajectory, with trillions of dollars left over. Of course, the global extrapolation could be conservative or unconvincing in different countries, especially with regard to potential adoption lags in some and the accelerating pace of renewable power adoption in many (e.g. Creutzig et al. 2017). But though speculative at the global scale, the analytic basis is sufficiently solid and aligned with actual progress for half the world that the global extrapolation offers both hope and a worthy direction to consider. (Livens 2017) points out that though these analyses do not use complex models except for simulating power-grid integration (where they used the best available models), their simple engineering-economic methodologies have shown superior predictive power both over the past 40 years and since these specific US and Chinese Reinventing Fire studies were published. 

[Amory Lovins, United States of America] | Noted - but beyond the scope of the section and not whether the expected submission might be in the scope of eq. 4.4.6.

5923 | 79 | 2 | 79 | 2 | There is a missing word “in” the phrase “that will not allow any sort of meaningful” [Sarit Kulkus, Turkey] | Accepted - this has been added to the text.

7977 | 79 | 2 | 79 | 3 | missing words [Amory Lovins, United States of America] | Accepted - missing word added

7834 | 79 | 2 | 79 | 3 | missing words [Amory Lovins, United States of America] | Accepted - missing word added

19763 | 79 | 5 | 79 | 8 | Agree and analyses are needed of the human rights impacts of adaptation actions as well as references here to the value of related approaches to adaptation. [Tara Shire, Ireland] | Noted - but beyond the scope of the chapter 4: Human rights as part of equity is discussed in chapter 5.

19139 | 79 | 9 | 79 | 10 | Worth repeating what the three main systems are [Sylva Frohnkamper, Germany] | Noted - “energy, land and urban” has been added to the sentence in parenthesis.

15047 | 79 | 15 | 79 | 16 | Climate policies do not have an agreed upon meaning, and as I have noted elsewhere in these comments, it should not be included within the scope of IPCC/UNFCCC products. [Peter Ahlen, United Nations of Areawward to say more clearly what exactly is missing from the literature. | Noted - it is by the beyond the scope of the section to open this debate, the sentence has been rephrased to say more clearly what exactly is missing from the literature.

19764 | 79 | 15 | 79 | 20 | There is an emerging literature on climate justice that can be called on here. [Shue, H. Climate Justice 2014. Oxford University press] | Noted - but beyond the scope of the section.

19765 | 79 | 15 | 79 | 20 | Further work is needed on assessing the differential impacts of 1.5-2 degrees from the perspective of rights. This should be flagged as an important area for future work. [Tara Shire, Ireland] | Noted - but beyond the scope of the chapter 4.

6591 | 79 | 16 | 79 | 16 | About the possibility of a new urban science. The half the world that the global extrapolation offers both hope and a worthy direction to consider. Lovins (2017) points out that though these analyses do not use complex models except for simulating power-grid integration (where they used the best available models), their simple engineering-economic methodologies have shown superior predictive power both over the past 40 years and since these specific US and Chinese Reinverting Fire studies were published. [Amory Lovins, United States of America] | Noted - but beyond the scope of the section to assess new science branches.


7647 | 79 | 24 | | | This may not be a section to which you wish to add further citations. However, I note that a key, recent publication on the ‘political economy of climate adaptation’ (mentioned in the text) is not in the list of references. That citation is Javeline, D., 2014. The Most Important Topic Political Scientists Are Not Studying: Adapting to Climate Change. Perspectives on Politics, 12, 420–434. [Conor Little, Denmark] | Noted - beyond the scope of the section to add further citations. However, I note that a key, recent publication on the ‘political economy of climate adaptation’ (mentioned in the text) is not in the list of references. That citation is Javeline, D., 2014. The Most Important Topic Political Scientists Are Not Studying: Adapting to Climate Change. Perspectives on Politics, 12, 420–434. [Conor Little, Denmark] | Noted - but beyond the scope of the section.

11172 | 79 | 25 | 79 | 27 | This section on knowledge gaps in urban environments should also consider loss and damage, and related concepts, including barriers and limits to adaptation. Also finance flows for adaptation are relevant here. [Michiel Schaeffer, Netherlands] | Taken into account - There is now a separate box on loss and damage.

3093 | 79 | 27 | | | considerable knowledge being built up by UN Habitat case studies and the Asian Development Bank - reference - ADB 2017. A Region at Risk - the consequences of climate change in Asia and the Pacific. [Barbara Norman, Australia] | Noted - but beyond the scope of the knowledge gap section to assess this emerging work.

11173 | 79 | 29 | 79 | 35 | On land systems, more information on examples of successful policy implementation related to land-based mitigation (that have led to co-benefits for adaptation, development, etc.) is needed. E.g. see Creutzig et al. 2015. [Michael Schaeffer, Netherlands] | Accepted - has been added to the text.
energy demand has very little scope for further growth, while at the same time providing universal access to energy, as many people will suffer from lack of access as we enable, but not least—how about if renewable energy (e.g. solar home systems) is used to increase energy access? [Michiel Schaeffer, Netherlands]

Consider to refer not to 'energy demand' but to 'fossil-fuel energy demand'; in fact there is a 'lot of scope' for the demand or renewable non-GHG.

Consider to introduce a more clear assessment about how much fossil fuel can still be taken out of the ground and on the potential of global / national technologies to enable this.

Consider to refer not to 'fossil fuel energy demand'; instead there is 'potential for renewable non-GHG.

No country is reaching, or is planning the preponderance of literature, including virtual consensus among the deepest students and practitioners of this subject is likely to reach 90-95% variable renewable generation.妹妹where large scale energy storage systems are required to enable realistic grid systems. IPCC should not perpetuate this misconceptions about how grids work, contradicted by extensive literature. We will be glad to supply just ask me at amory@rmi.org. The correct term is also "variable" not "intermittent" renewables. "Intermittent" is a reserved for unpredictable fossil

This paragraph on SRM implies that  SRM is an option that is being seriously considered as a feasible option, and underplays the risks. E.g. "how to facilitate dialogue to take stock of the collective efforts of parties in relation to progress toward the long term goal of the Paris Agreement. Since the long term goal is to hold the temperature increase to well below 2°C and pursue efforts to limit the increase to 1.5°C, this box should discuss 2°C as well.

Reducing Short-Lived Climate Pollutants (SLCPs) could be one way to reduce the reliance on negative emissions in a 1.5°C pathway—this is truly misleading and should be deleted. Reducing SLCPs can reduce peak temperatures, but it is the total CO2 that determines the long-term temperature rise. See (Rogelj et al. 2015). "Over longer timescales and for the same global warming in 2050, cases with larger CO2 budgets and more stringent CH4 abatement have committed, irreversible long-term warming, than cases with lower CO2 budgets and higher CH4." This should be made clear. This section is particularly misleading because it starts to lump SLCPs together, but in reality, and Black Carbon in line 10, while it is clear that Black Carbon is ineffecive for long-term warming and even peak warming: much of Black Carbon is co-ordinated with CO2 and its 1.5 and 2°C scenarios (van der Werf et al. 2009) as well as new pathways along with CO2 emissions long before peak warming. (Rogelj et al. 2014) "Downstreaming the effects of CO2 and short-lived climate forcer mitigation", PNAS

No country is reaching, or is planning the preponderance of literature, including virtual consensus among the deepest students and practitioners of this subject is likely to reach 90-95% variable renewable generation. Silverwhere large scale energy storage systems are required to enable realistic grid systems. IPCC should not perpetuate this misconceptions about how grids work, contradicted by extensive literature. We will be glad to supply just ask me at amory@rmi.org. The correct term is also "variable" not "intermittent" renewables. "Intermittent" is a reserved for unpredictable fossil

The assessment is problematic in several respects. Vane fertilisation should not be considered in same category. Consider the area must be carried out in accordance with London Convention. (2) BECCS and AR have been assessed but significance of ILUC remains contested. (David Cooper, Canada)
Important to compare risks to human rights from climate impacts to risks to human rights from climate action. Mary Robinson Foundation report on Zero Carbon, Zero Poverty finds that “Impacts of climate change can lead to rights violations of those arising from rapid climate action and that zero carbon is compatible with achieving the right to development, with a shift to Sustainable Development, poverty eradication and a more equitable and inclusive model of development.”

a) All countries are enabled to participate in the transition on the same time scale
b) Human rights and gender equality inform all climate and sustainable development actions

[276x84]

[Christian Holz, Canada]

Thi part needs quite some revisions, as it is not clear what is the objective, and what are the questions you want to address. The literature cited is OK, but you may also mention that the Paris Agreement does not indicate which metrics and time horizon that should be used in the calculations of CO2-equivalent emissions. And further how this may affect the weighting of gases in mitigation efforts. A reference may be given to Allen et al., 2016 (NCC) for further reading.

[Michel den Elzen, Netherlands]

It is misleading to state that all countries contribute to mitigation, since 1) not all countries signed the Paris Agreement and 2) some countries pledged to generate lower emissions by 2030. An alternative phrasing could read: "... all signatory countries committed to contributing to global emissions mitigation..." or "... all signatory countries committed to limiting their emissions..." [Fram robesto du Pont, Australia]

[Jan Fuglestvedt, Norway]

Box 4.12 may also mention that the Paris Agreement does not indicate which metrics and time horizon that should be used in the calculations of CO2-equivalent emissions. And further how this may affect the weighting of gases in mitigation efforts. A reference may be given to Allen et al., 2016 (NCC) for further reading.

[Michel den Elzen, Netherlands]

Noted and partly accepted

The Box is in Ch. 4. It is shared with all the other chapters given its importance in the Report. This added.

[Jan Fuglestvedt, Norway]

Box 12: The elaboration of consistency between NDCs and 1.5 scenarios is a key point in this report. It should be in the main body of the chapter. Also important is to address the differences in adoptions to NDCs and 1.5 scenarios. Figure 1 in Box 4.12 needs a title. [Hong Yang, Switzerland]

[Christian Holz, Canada]

This part needs quite some revisions, as it is not clear what is the objective, and what are the questions you want to address. The literature cited is OK, but you may also mention that the Paris Agreement does not indicate which metrics and time horizon that should be used in the calculations of CO2-equivalent emissions. And further how this may affect the weighting of gases in mitigation efforts. A reference may be given to Allen et al., 2016 (NCC) for further reading.

[Michel den Elzen, Netherlands]

Noted and partly accepted

The Box is in Ch. 4. It is shared with all the other chapters given its importance in the Report. This added.

[Christian Holz, Canada]

Thsi part needs quite some revisions, as it is not clear what is the objective, and what are the questions you want to address. The literature cited is OK, but all have a different objective (cost-effective pathways to 1.5C, assessing of NDCs by comparing them with efforts sharing regimes based on equity principles, etc.). I think you need to clarify the literature that have a particular objective. [Miclhel den Elzen, Netherlands]

[Christian Holz, Canada]

Accepted

[Christian Holz, Canada]

Thsi part needs quite some revisions, as it is not clear what is the objective, and what are the questions you want to address. The literature cited is OK, but all have a different objective (cost-effective pathways to 1.5C, assessing of NDCs by comparing them with efforts sharing regimes based on equity principles, etc.). I think you need to clarify the literature that have a particular objective. [Miclhel den Elzen, Netherlands]

[Christian Holz, Canada]

Accepted

[Christian Holz, Canada]

Thsi part needs quite some revisions, as it is not clear what is the objective, and what are the questions you want to address. The literature cited is OK, but all have a different objective (cost-effective pathways to 1.5C, assessing of NDCs by comparing them with efforts sharing regimes based on equity principles, etc.). I think you need to clarify the literature that have a particular objective. [Miclhel den Elzen, Netherlands]

[Christian Holz, Canada]

Accepted

[Christian Holz, Canada]

Thsi part needs quite some revisions, as it is not clear what is the objective, and what are the questions you want to address. The literature cited is OK, but all have a different objective (cost-effective pathways to 1.5C, assessing of NDCs by comparing them with efforts sharing regimes based on equity principles, etc.). I think you need to clarify the literature that have a particular objective. [Miclhel den Elzen, Netherlands]

[Christian Holz, Canada]

Accepted
Comment No | From Page | From Line | To Page | To Line | Comment | Response
--- | --- | --- | --- | --- | --- | ---
9020 | 82 | 3 | 82 | 3 | A comparison with no policy BAU is ok, as a reference, but from the UNEP report we know it is much more interesting to compared NDCs with current policies scenarios. The have been done in den Elzen et al. (2016), as cited here, and also done in UNEP (2015-2017). The current policies scenarios are based on multiple studies, including IEA, Climate Action Tracker, PBL RAGE and POLES model, but also on governmental studies. I would include a few sentences on the literature that compare the NDCs with current policies scenarios. I would delete Hof et al. (2017), and keep Roge et al. et al. in it, if you want to compare BAUs with NDCs. [Michiel den Elzen, Netherlands] | Accepted, text modified accordingly |
9021 | 82 | 3 | 82 | 4 | Wrong. For INDCs it is ok, for NDCs, it still changes, if parties rally, their INDCs become a NDC [Michiel den Elzen, Netherlands] | Accepted, text modified |
20416 | 82 | 4 | 82 | 8 | Critics do exists on the assumption that the Paris agreement takes us on 2°C warming by 2020? Does this assume a low climate sensitivity or a very rapid decarbonization after 2020? [Oliver Geden, Germany] | Rejected, the space is not available to add this sentence (to be reconsidered in TOD) |
11048 | 82 | 6 | 82 | 6 | 2.2 degrees is far outside the literature range and should not be reported here. When using a probability of 60%, all estimates are above degrees (see Roge et al. 2016). Therefore, probabilities should be reported here as well [Oliver Geden, Germany] | Accepted, probably added |
2097 | 82 | 8 | 82 | 8 | A reference to a recent publication looking at the likely 2°C warming under current policies and projections would be useful here. "Rafferty et al. (2011) Nature Climate Change, doi:10.1038/nclimate4326". The median warming and range identified here are less optimistic than that of the UNEP currently mentioned in the text. [Yann Robiou du Pont, Australia] | Rejected, reference not relevant (perhaps could be reconsidered for TOD) |
17209 | 82 | 10 | 82 | 12 | an additional study that estimates global emission levels achieved under the NDCs is: Held, C., Kartha, S. & Alkemade, T. Int Environ-Agreements (2017), doi:10.1007/s10784-017-9371-1 [Christian Held, Canada] | Accepted, reference added |
9024 | 82 | 11 | 82 | 11 | Replace Hof et al. at 2017 for den Elzen et al. 2016, as Hof et al. does not analyze the impact of NDCs in detail, it uses the information of den Elzen et al. Both publications are from the same authors. [Michiel den Elzen, Netherlands] | Accepted, Hof removed, den Elzen added |
7013 | 82 | 14 | 82 | 15 | Uncertainty instead of "Certainty" is more appropriate for the title of Box 4.12 since the assessment here shows that the NDCs are not in line with the 1.5°C pathways. Suggest to clearly state that there is little or no hope to keep warming below 1.5°C with the pledges agreed in the Paris Agreement. [Xia Ming Lee, China] | Noted, text agrees with comment but not possible to change Box title |
17243 | 82 | 17 | 82 | 17 | Plausible to add the fact that the US has pulled out of the Paris Agreement [Yann Robiou du Pont, Australia] | Rejected, reference not relevant (perhaps could be reconsidered for TOD) |
9022 | 82 | 21 | 82 | 23 | Check if the authors have easily run integrated assessment models. Again only cite the relevant literature. [Michiel den Elzen, Netherlands] | Accepted, text modified accordingly |
11176 | 82 | 21 | 82 | 23 | Several authors (Roge et al. 2016), Robiou du Pont et al. 2018, Vandal et al. 2016, Hof et al. 2017, ter Elst et al. 2015, Fujimoto et al. 2016) have run integrated assessment models to assess the contribution of NDCs to achieve the 1.5°C target in the Paris agreement - not all authors listed have done this. Some have compared NDC pathways with emissions pathways produced by IAMs. [Michiel Schaeffer, Netherlands] | Accepted, references added that indicated that some authors have run IAMs some have used BAUs or compared with IAMs |
2999 | 82 | 22 | 82 | 22 | Not all of the mentioned authors have run models. Some have simply used the existing modelling for their analysis. I suggest using "used" instead of "run". [Yann Robiou du Pont, Australia] | Accepted, this will also take care of the two above comments |
2999 | 82 | 24 | 82 | 24 | More precise. [Yann Robiou du Pont, Australia] | Accepted, probably added |
2999 | 82 | 24 | 82 | 25 | Grandma madeleine, "assumption" should be plural and read "assumptions" [Yann Robiou du Pont, Australia] | Accepted, Editorial |
2999 | 82 | 24 | 82 | 25 | Imprecise language on "that have looked into the question". There is no clearly laid-out question in the lines above. [Yann Robiou du Pont, Australia] | Accepted, text deleted, therefore comment not relevant anymore |
9023 | 82 | 25 | 82 | 27 | I would also cite the UNEP Gap report, as this is an assessment of existing scenarios that have analyed the aggregate effects of NDCs. [Michiel den Elzen, Netherlands] | Accepted, Gap Report added |
2071 | 82 | 26 | 82 | 27 | A reference to Hof et al. (2016) could be added: "Robiou du Pont et al. (2016), Nature Climate Change, doi:10.1038/nclimate3195". [Yann Robiou du Pont, Australia] | Accepted, reference added |
2672 | 82 | 33 | 82 | 33 | The word "region" seems imprecise. Within specific regions, some countries may over-deliver while others under-deliver. Using "countries" would be more precise. [Yann Robiou du Pont, Australia] | Accepted, text changed |
2673 | 82 | 37 | 82 | 37 | Additionally to Figure 2.10 of section 2.3.3, a reference to Figure 4.14, which is included in the same Box 4.12 in this draft, would clearly highlight this statement. [Yann Robiou du Pont, Australia] | Accepted |
17244 | 82 | 47 | 82 | 48 | Change "NDCs to NDCs and will results to its will result" [Himangana Gupta, India] | Accepted Editorial |
2674 | 82 | 49 | 82 | 49 | Delaying emissions mitigation would also increase the risk of overshooting the warming threshold and the risk of adverse climate impacts. Since the recent sentence discusses this more in depth, it would be useful to mention it here. A suggestion is: "resulting in higher costs, a higher effort of negative runs". [Yann Robiou du Pont, Australia] | Rejected, no space to add this sentence (to be reconsidered in TOD) |
2675 | 82 | 51 | 82 | 51 | A comparison point is lacking in the use of the word "deeper". A suggestion is: "Implementing more ambitious emissions reduction than current NDCs imply by 2030." [Yann Robiou du Pont, Australia] | Noted, but text is already implying what suggested |
17245 | 82 | 52 | 82 | 52 | Change the risk to the range [Himangana Gupta, India] | Accepted Editorial |
17596 | 83 | 1 | 83 | 12 | It is stipulated that the Second Order Draft will elaborate on how NDCs comply with various equity principles. This is an important issue, and there is a large discussion in the existing literature. A recent contribution, Hidt, C., et al., Int. Environ-Agreements (2017), https://doi.org/10.1007/s10784-017-9371-1, finds results very different from e.g. Robiou du Pont et al. (2017), which is cited in the FOD. A comprehensive critique of Robiou du Pont et al. is under review for Nature Clim Change (Karthe, S. et al. 2018) from the authors of the AR5 categorization of existing quantifications of equity principles in the literature, rather than being anchored in specific understandings of equity drawn from ethical or normative theory. This leads to some unfortunate results, where (e.g. in Robiou du Pont et al.) some version of "grandfathering" is included as an equity principle and built into the application of several principles, despite the fact that the principle has no support as an equity principle in the literature (cf. Karthe et al. in review). In other words, the principle not supports an equity principle in the literature, and is used instead as a way to achieve a result from a principle that is not supported. [Oliver Boucher, France] | Accepted, added discussion on the different equity principles as proposed by the comment and references added |

IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4

Do Not Quote, Cite, or Distribute Page 144 of 159
2076 83 2 83 5 5 Additionally, other studies inform on the compliance of NDCs with equity principles for the Second Order Draft. The study (Robiou du Pont et al. 2015) provides assessments of the consistency of NDCs, at the national or regional levels, with the Paris Agreement emission pathways of 1.5 °C and 2 °C, and the net-zero emissions goal under the five effort-sharing categories quantified in the IPCC-AR5 (in Figure 6.28). “Robiou du Pont et al. (2016), Nature Climate Change, doi:10.1038/nclimate3168.” Additionally, the study of Pan et al. (2017) provides assessments of the consistency of NDCs at the national level under global emissions pathways leading to 2 °C or 1.5 °C for a range of effort sharing approaches (DOI: 10.1016/j.envsci.2017.04.020). [Yann Robiou du Pont, Australia]

2077 83 3 83 6 6 The statement “Most of the authors agree on a multi-criteria assessment framework based on six equity principles of effort-sharing” is vague or incorrect. Should that statement refer to a sub-selection of the authors in the previous sentence, there is an inconsistency in the authors’ names. Should that statement refer to all authors in the field of equity modeling, that sentence seems incorrect. In that literature, many (if not most) authors have suggested single-criterion assessments. Furthermore, amongst the cited authors, Hilmer et al. (2017) uses the effort-sharing approaches of Höhne et al. (2014 DOI: 10.1080/14693062.2014.949462), which is also the multi-criteria assessment used in the IPCC-AR5 (Figure 6.28). This assessment only refers to five categories based on notions of equity. The additional “equal marginal abatement costs” approach based on cost-effectiveness is not based on equity and the author indicates “it as a reference”. The IPCC-AR5 describes the “equal marginal abatement costs” category as a representation of the initial allocation that would emerge from a global price on carbon and uses it “as a reference against which to compare the implications of other regimes”. The other study mentioned here Pan et al. (2017), does include six effort-sharing approaches including the five approaches of Höhne et al. (2014) covered in the IPCC-AR5. The additional approach named “responsibility,” “equal marginal abatement costs” approach. The effort sharing approaches used by Höhne et al. (2017) and Pan et al. (2017) are different, and it is misleading to declare agreement across most authors. Fundamentally, the effort-sharing approaches included in the references mentioned here, as well as others (Robiou du Pont et al. 2016), are based on a combination of only three principles of equity as described in Hilmer et al. (2014) and IPCC-AR5 (table 6.5): equality, responsibility, capability-need. A suggestion is “in accordance with the IPCC-AR5, several authors modelled multi-criteria assessment frameworks based on three principles of equitable effort-sharing (Hilmer et al. 2017, Pan et al. 2017 and Robiou du Pont et al. 2019).” [Yann Robiou du Pont, Australia]

2078 83 6 83 6 6 The study by Jung et al. (2017) does not seem relevant here. This study does not model or discuss the isolation of effort-sharing principles. This study reviews the existing assessments and simply describes the seven (not as an stated) effort-sharing indicators used by an online assessment tool, which is not peer-reviewed. [Yann Robiou du Pont, Australia]

2079 83 7 83 7 7 The statement about the four “principles” mentioned in Robiou du Pont et al. (2016) does not state all four of the same equity principles. “Many African countries’ NDCs are actually more ambitious than any equity principles.” The study does not mention any equity principles. [Yann Robiou du Pont, Australia]

2080 83 8 83 10 10 The study of Robiou duPont et al. (2016) does not state that all four are the same equity principles. “Many African countries’ NDCs are actually more ambitious than any equity principles.” An equation-based approach, which is not mentioned in the study, is used. “Robiou du Pont et al. (2016) developed a typology of NDCs that is consistent with the typology of NDCs of the Middle East and Africa that are consistent with some 1.5°C allocations.” [Yann Robiou du Pont, Australia]

2081 83 9 83 8 8 Article “Robiou du Pont (2016)” into grey shaded Mendeley field with “2016” [Wilfran Moufouma Okia, France]

2082 83 10 83 12 12 The statement does not hold well. The study of VanDijk et al. (2016) allocates emissions allowances of a 2°C pathway across countries through the cost-optimizing approach under a differentiated carbon price for countries. The study of Robiou du Pont et al. (2016) allocated emissions allowances of both a 2°C and a 1.5°C pathway to countries following the effort-sharing approaches described earlier in the text. [Yann Robiou du Pont, Australia]

2083 83 11 83 11 11 The term “in any case” sounds vague and not appropriate in this context. [Yann Robiou du Pont, Australia]

2084 83 12 83 12 12 Since the FOD, another study became available that, based on three different equity parameterizations, contrasts countries’ NDCs with their allocation under these equity benchmarks and finds that all NDCs fail on some equity principles. Many African countries’ NDCs are actually more ambitious than any equity principles. “Many African countries’ NDCs are actually more ambitious than any equity principles.” The other study mentioned here Robiou du Pont et al. (2016), does include six effort-sharing approaches including the five approaches of Höhne et al. (2014) covered in the IPCC-AR5. The additional approach named “responsibility,” “equal marginal abatement costs” approach. The effort sharing approaches used by Höhne et al. (2017) and Pan et al. (2017) are different, and it is misleading to declare agreement across most authors. Fundamentally, the effort-sharing approaches included in the references mentioned here, as well as others (Robiou du Pont et al. 2016), are based on a combination of only three principles of equity as described in Hilmer et al. (2014) and IPCC-AR5 (table 6.5): equality, responsibility, capability-need. A suggestion is “in accordance with the IPCC-AR5, several authors modelled multi-criteria assessment frameworks based on three principles of equitable effort-sharing (Hilmer et al. 2017, Pan et al. 2017 and Robiou du Pont et al. 2019).” [Yann Robiou du Pont, Australia]

2085 83 13 83 13 13 Grammar mistake, “allowance” should be plural and read “allowances”. [Yann Robiou du Pont, Australia]

2086 83 14 83 14 14 The IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4

2087 83 15 83 15 15 Accepted, the references added

2088 83 16 83 16 16 Accepted Reference and text added

2089 83 17 83 17 17 Noted, but not relevant as this section has been removed

2090 83 18 83 18 18 Accepted sentence removed

2091 83 19 83 19 19 Accepted, text modified as suggested

2092 83 20 83 20 20 Accepted, the references added and text modified

2093 83 21 83 21 21 Accepted, not relevant as this section has been removed

2094 83 22 83 22 22 Noted, but not relevant as this section has been removed

2095 83 23 83 23 23 Accepted, the references added and text modified

2096 83 24 83 24 24 Accepted, the references added and text modified

2097 83 25 83 25 25 Accepted, the references added and text modified

2098 83 26 83 26 26 Accepted, the references added and text modified

2099 83 27 83 27 27 Accepted, the references added and text modified

2100 83 28 83 28 28 Accepted, the references added and text modified

2101 83 29 83 29 29 Accepted, the references added and text modified

2102 83 30 83 30 30 Accepted, the references added and text modified

2103 83 31 83 31 31 Accepted, the references added and text modified

2104 83 32 83 32 32 Accepted, the references added and text modified

2105 83 33 83 33 33 Accepted, the references added and text modified

2106 83 34 83 34 34 Accepted, the references added and text modified

2107 83 35 83 35 35 Accepted, the references added and text modified

2108 83 36 83 36 36 Accepted, the references added and text modified

2109 83 37 83 37 37 Accepted, the references added and text modified

2110 83 38 83 38 38 Accepted, the references added and text modified

2111 83 39 83 39 39 Accepted, the references added and text modified

2112 83 40 83 40 40 Accepted, the references added and text modified

2113 83 41 83 41 41 Accepted, the references added and text modified

2114 83 42 83 42 42 Accepted, the references added and text modified

2115 83 43 83 43 43 Accepted, the references added and text modified

2116 83 44 83 44 44 Accepted, the references added and text modified

2117 83 45 83 45 45 Accepted, the references added and text modified

2118 83 46 83 46 46 Accepted, the references added and text modified

2119 83 47 83 47 47 Accepted, the references added and text modified
The phrase "At the national level" may read instead as "At national the level" [Siir KILKIS, Turkey] Taken into account. The adaptation section of this box is being rewritten for SOD

Box 4.12 could be shifted to section 4.3.7 [Himangana Gupta, India] Noted. This is Cross-chapter Box, and does not belong to chapter 4 only

Box 4.13 is on SRM, there is section 4.3.7 on SRM. Is not that too much focus on one single option. [Joyashree Roy, India] Noted. The most discussion about SRM is focused in the SRM box and the section 4.3.7 is

Thanks for all your hard work on this report. [David Morrow, United States of America] Noted, thank you!

Heckendorn, Thomas Peter, David W. Keith, “Efficient Formation of Stratospheric Aerosol for Climate Engineering by Emission of Condensible Vapor in Injection in Weisenstein et al. (2015). Advantages are better control of sulfate particle size, maintaining a distribution closer to optimal for radiative


Figure 1 in Box 4.12. This Figure from the study Ropou du Pont does not assess the impact of NDCs and a comparison of 1.5C and 2C. This study uses the old least-cost pathways of IPCC AR5, assuming least costs reductions starting in 2010. This is not realistic anymore (given the rise in GHG emissions), and therefore the UNEP started already in 2014 to compare the NDCs with delayed pathways (limited action by 2020) (2020 pledges), and cost-optimal reduction starting from 2020 to meet 1.5 and 2C. I would delete this figure as NOT CONSISTENT with the pathway of Chapter 2, which mainly assume these delayed pathways. The authors may want to include the Figure of the UNEP Gap Report, that shows the difference between the 1.5C pathways of Chapter 2 and the NDC emission scenarios (conditional and unconditional). It further also shows the baseline scenarios (no policy), and current policies scenario. I think this figure would better fit here. The figure is based on the assessment of the most recent Burton that is also cited in this Box [Michel den Elzen, Netherlands].

The box 4.13 on SRM methods, effectiveness and technical feasibility is not always consistent in the picture of SRM presented. Some parts treat SRM as a feasible option (e.g. SRM should only be used in combination with emission reduction and CDR - line 47) while others identify the very high risks and uncertainties ("risks of SRM deployment for global food security and ecosystem health would outweigh the benefits..."). The state of knowledge on SRM is still clear that the risks are too high, and this should be clearly stated consistently throughout the box. It might be useful to reorder the box, so that some of the risks and governance issues (which are very relevant to policy-makers) are highlighted before the technological feasibility. [Michel Schaeffer, Netherlands].

Noted. Not included in the Box as the Box deals only with NDCs. In Section 4.4.1 the comment is addressed and National Climate Change Strategies and Action Plans are mentioned.

Noted, although the focus of the box is on NDCs, NAPs are mentioned because of their role. Noted. Taken into account. The adaptation section of this box is being rewritten for SOD

Taken into account, Box is rewritten significantly in order to be consistent with all Report. While we are assessing balance of literature, we should mention different points of view

Box 12 could be shifted to section 4.3.7 [Himangana Gupta, India] Noted. This is Cross-chapter Box, and does not belong to chapter 4 only

Noted, but not included in the Box as the Box deals only with NDCs. In Section 4.4.1 the comment is addressed and National Climate Change Strategies and Action Plans are mentioned.

Box 4.13 on SRM very useful if possible (given the limited literature as pointed to p 90 line 19) some more emphasis on assessment would be good [Jan Fuglestvedt, Norway]

Taken into account. Assessment added. Thank you!

Noted, although the focus of the box is on NDCs, NAPs are mentioned because of their role. Noted. Decisions of Convention on Biological Diversity is addressed in 4.3.9

Taken into account, but we are limited in space and cannot have a long discussion about proposed issue

Taken into account, but not included in the Box as the Box deals only with NDCs. In Section 4.4.1 the comment is addressed and National Climate Change Strategies and Action Plans are mentioned.


Noted. Decisions of Convention on Biological Diversity is addressed in 4.3.9

Taken into account, but not included in the Box as the Box deals only with NDCs. In Section 4.4.1 the comment is addressed and National Climate Change Strategies and Action Plans are mentioned.
The idea of directly altering cloud reflectivity with CO2 is a type of SRM that is problematic. While they are often discussed together, CO2 targets outgoing infrared radiation rather than incoming solar radiation. So it is technically SRM. Some researchers (e.g., Hubert & Rechwan 2015) class them together under the heading of “radiation management”; but this is conceptually problematic, too. I don’t have a real solution for you, except maybe to add a sentence pointing out that while this isn’t technically “radiation” management, it is often discussed alongside SRM techniques. [David Morrow, United States of America]

The original reference for a potential implementation of this approach should be listed. It is: Early, J. T., 1989: Space-based solar screen to offset the greenhouse effect, Journal of the British Interplanetary Society 42, 567-569 [Michael MacCracken, United States of America]

The uncertainty of the effectivity of MCB is discussed in the Box

The statement needs a bit of rewriting. Such an approach is likely technically feasible, but the costs would be much greater than other approaches (including greenhouse mitigation and other SRM approaches) that I think should be said to not be economically feasible, even though it might have similar unintended side effects than other SRM approaches (such as aerosol scattering that would affect the ratio of diffuse to direct radiation). [Michael MacCracken, United States of America]

Davin et al. 2014 needs a Mendeley link [Wilfran Moufouma Okia, France]

Cirrus cloud thinning is not a form of SRM. It may be convenient to treat it in the same section, but I think that should be made clear. [Oliver Morton, United Kingdom (of Great Britain and Northern Ireland)]

There is a great uncertainty on the effectivity of MCB. See eg Joyce Penner discussions. http://clasp-research.engin.umich.edu/faculty/penner/publications.php. MCB should not be included as “an effective” measure. Also stated in Table 1. [Elenita Daño, Philippines]

Corollary 1: Space-based solar screens to offset the greenhouse effect. [Rachel Williams, United States of America]


Ahlm et al. 2017 needs a Mendeley link [Wilfran Moufouma Okia, France]

Ahlm et al. 2017 needs a Mendeley link [Wilfran Moufouma Okia, France]

The impact of stratospheric aerosols on climate. [Michael MacCracken, United States of America]

The differences in styles of geoengineering (CGT) has a type of SRM is problematic. While they are often discussed together, CGT targets outgoing infrared radiation rather than incoming solar radiation. So it is not technically SRM. Some researchers (e.g., Hubert & Rechwan 2015) class them together under the heading of “radiation management”; but this is conceptually problematic, too. I don’t have a real solution for you, except maybe to add a sentence pointing out that while this isn’t technically “radiation” management, it is often discussed alongside SRM techniques. [David Morrow, United States of America]

It may be convenient to treat it in the same section, but I think that should be made clear. [Oliver Morton, United Kingdom (of Great Britain and Northern Ireland)]

The statement needs a bit of rewriting. Such an approach is likely technically feasible, but the costs would be much greater than other approaches (including greenhouse mitigation and other SRM approaches) that I think should be said to not be economically feasible, even though it might have similar unintended side effects than other SRM approaches (such as aerosol scattering that would affect the ratio of diffuse to direct radiation). [Michael MacCracken, United States of America]

Birner et al. 2015 needs a Mendeley link [Wilfran Moufouma Okia, France]
Penner also questioned the measures about the effects of the Mount Pinatubo eruption in 1991. This statement needs to be nuanced. [Elenita Daño, Philippines]

Cirrus thinning is NOT well studied. There are major doubts about the ability of climate models to simulate cirrus in the current climate, let alone the change "reduce" to "would reduce" [Alan Robock, United States of America]

The 60% is specific to a particular amount of geoengineering deployed; not a characteristic of the method itself; this is a choice. Sentence needs to be rephrased to: "The most often considered SAI approach", since this has not been in use yet - other than in models [Helene Muri, Norway]

It can be shown [Boucher et al., GRL, submitted] that the combination of SAI and MCB results in a forcing that could be more homogeneous in space and time [Oliver Boucher, France]

Cirrus thinning is not well studied. [Oliver Morton, United Kingdom (of Great Britain and Northern Ireland)]


What does "technique and level and aerosol injection area." mean? Level in vertical? What differences in technique? [Alan Robock, United States of America]

It can be shown (Boucher et al., GRL, submitted) that the combination of SAI and MCB results in a forcing that could be more homogeneous in space and time [Oliver Boucher, France]

Fifty "Gt" instead of "Tg" [Radim Tolasz, Czech Republic]

Noted. This sentence is deleted from the final text

Latham et al. 2012 needs a Mendeley link [Wilfran Moufouma Okia, France]

Do Not Quote, Cite, or Distribute Page 148 of 159

Page 148 of 159
I am not sure cirrus cloud thinning is "well studied". Most importantly there is not much evidence of its feasibility. SAI and MCB have leverage - SAI has leverage because the lifetime of the stratospheric aerosols is relatively long. MCB has leverage because it is "relatively easy to spray large quantities of sea salt into the marine boundary layer. For cloud thinning, the amount of material needed might be small but it would need to be sprayed everywhere all the time. [Olivier Boucher, France]

13418 37

The degree of cooling from cirrus cloud thinning also depends on the location and purity of the ice clouds and the time of day and year, i.e. the method is most effective during daytime and polar summer. [Murt et al., 2014; Man H., Kristjansson, J. E., Stonehouse, T. and Pfeffer, M. A. (2014). The dynamic effects of modifying cirrus clouds in a climate engineering framework. Journal of Geophysical Research - Atmospheres, 119, 4174 - 4191. doi: 10.1002/2013JD201053]. [Helene Muri, Norway]

13419 37

Schmidt can be replaced by "Mark". [Helene Muri, Norway]

13417 37

The text has been updated to clarify that this table adresses only technical considerations. [David Cooper, Canada]

15869 37

Crock et al. 2010; Murt et al. 2014; Stonehouse et al. 2014 need Mendeley links [Wilmot Mumford Oka, France]

15660 41 86

MacMartin et al. 2017 needs a Mendeley link [Wilmot Mumford Oka, France]

4107 57

Box 4.13: Tab 1, row 2-7, column 5 - Use "S" instead of "Sc" (Hadley Model, Czech Republic)

4108 57

Box 4.13: Tab 1, row 6-7, column 5 - Use "p.3d" instead of "Adv" (Hadley Model, Czech Republic)

4201 87

The statement: "If the stratospheric heating and feedbacks of SAI stratospheric heating increases the emission of LW radiation, hence would contribute to enhance the effective radiative forcing of SAI." [Olivier Boucher, France]

21192 87

2nd column heading is potentially misleading the global average temperature that is stabilised [David Cooper, Canada]

21193 87

clarify that this table addresses only technical considerations [David Cooper, Canada]

20143 87 93

Chapter 4 authors should delete this box, and Table 1 in Box 4.13 in particular - it is clearly by geometric-meaning/SRM proponents who aim to undermine SAI and promote continued rapid rises. Why does this take only look at technical cost and not climate "damage potential"? It is excessively unfounded. It is also repetitive - why have an additional box if all SRM is covered in the main body of the chapter? [Jakub Furh, Germany]

16451 87 1 87 2

Regarding the heading of the second column, the wording does not seem optimal. Given that other changes will be going on, such as continued ice sheet mass loss and sea-level rise, and ongoing adjustment due to thermal inertia and the removal of sulfates, etc., it seems to me that a better heading would be "Ability to bring global temperature back toward its baseline state" - just don't think stabilization is really the word to be using. [Michael MacCracken, United States of America]

16452 87 1 87 2

On SAI disadvantages, the real limitation is being able to create longitudinal distributions. It is possible to achieve some variation of latitudinal, hemispheric, and temporal distributions by adjusting injection latitudes, altitudes and timing. With regard to the illustrative climatic responses shown, all are for very large amount and quite high RCP scenarios typically much greater than has been discussed in this report. [Michael MacCracken, United States of America]

16453 87 1 87 2

It would seem that the examples and citing for MCB should include the proponents of the approach and not just Krivobok et al., 2013. [Michael MacCracken, United States of America]

16454 87 1 87 2

Regarding the row on cirrus thinning, the text at page 86, lines 38-39 indicate the approach has been "well studied" and yet the entry here is very sparse. This is a rather obvious mismatch. [Michael MacCracken, United States of America]

11109 87 1 87 3

The authors have modified a table from MacMartin, Rieke, and Keith (forthcoming) making the table incorrect. The authors added columns for "application burden" and "climatic response". I believe the intention was to add specific examples that demonstrated the general claims made in the first three columns (the original table), however the modification is incorrect. One cannot determine why specific examples were chosen because no conclusions are drawn from the examples presented. We do not see how simply choosing better examples can solve the basic design problem that there is not a clear relationship between the claims in the original MacMartin, Rieke, and Keith table and these additional examples. Suggest that examples be integrated in the text if they serve a useful function but I don't think these new columns should be added or that these new columns should be removed from the table. [Grini, A., Schulz, M., and Kristjansson, J. E. (2017). Climate response to aerosol injection geoengineering: a multi-method comparison. Journal of Climate, 30, 4708-4726. doi: 10.1175/JCLI-D-17-0306.1. I will send it to you. [Helene Muri, Norway]

11108 87 1 87 2

The table is significantly revised in the SOD, the section on cirrus thinning is also revised.

16461 87 1 90 54

Box 4.13, Table 1, all references need Mendeley links [Wilmot Mumford Oka, France]

13423 87 2

In the table regarding the MCB information, columns 2, 7, 9, "system-level analysis of cost of deployment" is confusing, since the deployment costs are discussed on page 40. [Helene Muri, Norway]

13424 87 2

Regarding RPC, S, start in 2020; 212 Tg yr-1 dry sea-salt aerosol emissions in the marine boundary layer 30°S - 30°N: the emission strengths here should be 212 - 250 Tg yr-1, and Ahti et al. (2017) should be cited in addition to Kriviok et al. (2013). [Helene Muri, Norway]

4402 87 2 87 2

Kwok et al. (2017) is the previous comment - there is another more recent reference to add to the table [Doug MacMartin, United States of America]

1632 87 2 87 2

In Box 4.13, Table 1, "Disadvantages" column heading needs a footnote that says "disadvantages listed here are direct effects of each specific approach, whereas there are many other disadvantages to SLM in general, discussed in the text. [Alan Robock, United States of America]

633 87 2

In Box 4.13, Table 1, Cirrus thinning, Advantages box: Change "comparisons" to "comparison", may not reduce precipitation like SAI [Alan Robock, United States of America]

1635 87 2

In Box 4.13, Table 1, Cirrus thinning, References box: There are several references that can be listed here. [Alan Robock, United States of America]

11387 9 87 3

In Table 4, I don't think space mirrors deserve a seat at the table. [David Morrow, United States of America]

1639 88

Change "et. al." to "et al." twice in this line, change "Irvin" to "Irvine" [Alan Robock, United States of America]

1637 88

Editorial comment. Corrected

1638 88

Comment: The table is significantly revised in the SOD. [Alan Robock, United States of America]
IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4

1653  88  14  88  16
Discussion of lifetime here is wrong. You have to define “lifetime”. The typical metric is “e-folding lifetime,” which for the 1991 Pinatubo aerosol was one year. (Alan “Italics” means nothing unless you give the year of citation, as it has enjoyed many times) [Alan Robock, United States of America]

1657  88  18  88  16
This criticism is really inappropriate. Of course, SRM reduces the intensity of the hydrological cycle compared to 4 times CO2—-that is the whole intent.

1640  88  18  88  27
Indeed, most of the discussion has been about thinking SRM as a large emergency response--and there are all sorts of problems that arise if it is the (planned approach, including that the proposed emergency situation (e.g., sudden collapse of the West Antarctic ice sheet) are simply not reversible by SRM in addition, the shock to the system of a large and sudden application of SRM would likely have its own quite large consequences, and not necessarily beneficial in the near term plus requiring the large level of interventions be continued even if there are problems. A much more sensible scenario and application of SRM would be a gradual phasing in to offset the temperature overshoot that has been noted as the concern in this report. This type of approach really needs to be discussed, particularly because the types of complications would be much smaller and the gradual phasing in would allow iterative adjustments and learning while doing. [Michael MacCracken, United States of America]

14326  88  48  89  51
This the text is a duplicate from chapter 3 and may be cut. [Helene Murt, Norway]

14403  88  51  89  54
The statement that SG and SAI are “designed to offset some fraction of the global mean warming”, is not true, the fraction is a choice (that particular simulation is chosen to make, not a property of SAI per se). Similarly, any particular simulation might be set up to balance a radiative forcing, but SG and SAI most likely are not--and are included here. [David MacMartin, United States of America]

1640  88  53  89  54

14494  88  1  89  1
Add citation to the most recent literature (so recent it hasn’t yet appeared, so you couldn’t have known about it). Ternes, S., J. H. Rohrer, M. M. Mike, B. Krall, D. G. MacMartin, F. Vitt, J. Tribbia, and J.-F. Lamarque, “Sensitivity of aerosol distribution and climate response to stratospheric SO2 injection locations”, submitted. [David MacMartin, United States of America]

1653  89  9  89  9
Noted. This sentence is deleted from the final text.

14405  89  10  89  10
Unfortunately, there is no data for simulations where the forcing is uniform in season and latitudes, which is not required. Basically, as I have said elsewhere, there has yet to be engineering of the geoengineering—that is optimization of the radiative balance by deploying aerosols so it might have less aerosol at low latitudes and a bit more at higher latitudes. Thus the criticism here is not really as an inherent problem with SRM just with the model simulations that have been done to date. The next several lines similarly may be criticisms of the particular simulation, but are not inherent shortcomings of SRM. [Michael MacCracken, United States of America]

16457  89  13  89  16
This criticism is really inappropriate. Of course, SRM reduces the intensity of the hydrological cycle compared to 4 times CO2—that is the whole intent. / What matters is how the intensity of the cycle compares to the baseline case, and whether the 4XCO2 case without SRM is a worse or better situation compared to 4XCO2 with SAI. Basically, the comparison here is the wrong one to be concerned about. [Michael MacCracken, United States of America]

16458  89  16  89  16
Agreed, the comparison is not the one to be making—what is of concern is how the case of elevated GHGs without SRM compares to the case for elevated GHGs with SRM. [Michael MacCracken, United States of America]

Do Not Quote, Cite, or Distribute Page 150 of 159
Page 150 of 159
<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>16409</td>
<td>89</td>
<td>27</td>
<td>89</td>
<td>26</td>
<td>But how different, and how different compared to the situation for SRM. Of course it would be better to do greater mitigation, but SRM is not being proposed: as a substitute for mitigation, but as an appropriate one.</td>
<td>Rejected. The important point is that SAI does not restore pre-industrial conditions but creates novel climate conditions.</td>
</tr>
<tr>
<td>16460</td>
<td>89</td>
<td>29</td>
<td>89</td>
<td>35</td>
<td>Some 20 or 25 general conclusions to draw here— it may not be perfect, but how bad would it be? - Such a statement deservedly is not justifiable. - And again, what matters is the comparison to the situation without SRM, not to a situation assuming additional mitigation. - This article assumes that the side-effects of SRM are not too high. There is an implicit assumption that we should not have a large impact on SRM.</td>
<td>Rejected. The important point is that SAI does not restore pre-industrial conditions but creates novel climate conditions.</td>
</tr>
<tr>
<td>16461</td>
<td>89</td>
<td>37</td>
<td>89</td>
<td>39</td>
<td>Well, how for considering an alternative to a massive alternative application of SRM [Michael MacCracken, United States of America]</td>
<td>Noted. Moderate SRM and “peak-shaving” approaches are now mentioned more prominently at the start of the cross-chapter box.</td>
</tr>
<tr>
<td>12292</td>
<td>89</td>
<td>37</td>
<td>89</td>
<td>41</td>
<td>Some nuances regarding possibilities for using SRM to reduce risk, duration and magnitude of overshoot could be included.</td>
<td>Noted. Moderate SRM and “peak-shaving” approaches are now mentioned more prominently at the start of the cross-chapter box.</td>
</tr>
<tr>
<td>20426</td>
<td>89</td>
<td>37</td>
<td>89</td>
<td>41</td>
<td>The idea is at the point in the context of this report, but seems to be lost in the very long box. Many of the side effects of SRM would be lost in the noise if you're talking about a small SRM effort to shave a 2°C or 2.5°C warming.</td>
<td>Rejected. Lack of impact on ocean acidification needs to be mentioned.</td>
</tr>
<tr>
<td>16462</td>
<td>89</td>
<td>37</td>
<td>89</td>
<td>41</td>
<td>The report states that “traditionally considered SRM implementation such as SAI do not have scope for regional adjustment of the applied radiative forcing.” This statement is not accurate. The regional coverage of SAI strongly depends on injection location, regional localization of RF-through SRM can be achieved. Niemeier et al. [2011] showed that with equalitarian injections, the resulting aerosol plumes exhibit different spatial distributions depending on injection locations. Robock et al. [2008] showed different aerosol spatial distributions depending on whether the injection was equatorial or near. In an extreme case, it was shown that with injections at low altitudes, regional control of the aerosol plume down to state level was possible (Bernstein et al., 2013), albeit at a cost of low RF efficacy. L. Niemeier, H. Schröder, and C. Timmreck, “The Dependence of Geographically Sulfate Aerosol on the Emissivity Strategy,” Atmospheric Science Letters 12 (2011): 188-194; Alan Robock, Luke Oman, and Gregory J. Stenchikov, “Regional Climate Responses to Geosequestration with Tropical and Andes SO2 Injections,” Journal of Geophysical Research 113 (2008), doi: 10.1029/2008JD010550; D.N. Bernstein, J.D. Neelin, Q.B. Li, and D. Chen, “Could Aerosol Emissions Be Used for Regional Heat Wave Mitigation?”. Atmospheric Chemistry and Physics 13 (2013): 675-809] [Joshua Horton, United States of America]</td>
<td>Noted. Literature could not be included in detail because of space limits.</td>
</tr>
<tr>
<td>11095</td>
<td>89</td>
<td>43</td>
<td>89</td>
<td>51</td>
<td>There should be reference to technologies that produce “Changes in the adds of agricultural land.” which could include genetic engineering, synthetic biology, etc. especially as this relates to “regional SRM” which also needs to be expanded. This may imply a range or risks, including the use of symbiotic crops and GMOs, as well as other impacts on crops, vegetation and biodiversity. Additionally, the efficacy would be very low, as stated, so I suggest DELETION of this para. [Elenita Darbo, Philippines]</td>
<td>Rejected. All of the box mentions that considered RM measures are generally untested and risky.</td>
</tr>
<tr>
<td>15700</td>
<td>89</td>
<td>43</td>
<td>89</td>
<td>51</td>
<td>There should be reference to technologies that produce “Changes in the adds of agricultural land.” which could include genetic engineering, synthetic biology, etc. especially as this relates to “regional SRM” which also needs to be expanded. This may imply a range or risks, including the use of symbiotic crops and GMOs, as well as other impacts on crops, vegetation and biodiversity. Additionally, the efficacy would be very low, as stated, so I suggest DELETION of this para. [Elenita Darbo, Philippines]</td>
<td>Rejected. All of the box mentions that considered RM measures are generally untested and risky.</td>
</tr>
<tr>
<td>15452</td>
<td>89</td>
<td>43</td>
<td>89</td>
<td>51</td>
<td>The report asserts that “It is important to note that independently of any regional footprint of application, changes in temperature that result from changes in radiative forcing (such as with SAI-based SRM), but also land-based changes in surface albedo do not address non-temperature impacts of greenhouse-gas concentrations, and in particular ocean acidification (see Chapter 3, Section 3.3.1.1, IPCC 2014).” This statement is misleading. Whilst SRM is not a substitute for emissions control it seems very likely to reduce the atmospheric carbon burden and the ocean carbon content compared to a scenario without SAI and this should be noted. SRM would lower temperatures reducing a number of positive carbon-climate feedbacks, specifically the loss of perennial carbon and the projected loss of carbon stored in soils in a warmer world [Klein et al. 2017; Mathew et al. 2017; Tjiputra et al. 2018]. These results are noted in chapter 3 but should be referred to here as well. In addition, higher temperatures will increase demand for cooling and reduce the efficiency of thermal power plants [Klein et al. 2017; David W. Keith, Gerret Wagner, and Claire L. Zabel, “Solar Geosequestration Reduces Atmospheric Carbon Burden,” Nature Climate Change 7 (2017): 617-619; N. Damron Mathews and Pen Caldecott, “Transient Climate-Carbon Simulations of Planetary Geosequestration,” PNAS 104 (2007): 9694-9694; T.F. Tjiputra, A. Graf, and H. Lee, “Impact of Idealized Stratospheric Aerosol Injection on the Large-Scale Ocean and Land Carbon Cycles,” JGR Biogeosciences 121 (2016): 2-27] [Joshua Horton, United States of America]</td>
<td>Rejected. Albedo-based methods do indeed not directly counteract ocean acidification. Justification through carbon-cycle feedbacks is too far-fetched.</td>
</tr>
<tr>
<td>11092</td>
<td>89</td>
<td>53</td>
<td>89</td>
<td>55</td>
<td>How can we say only temperature is influenced by SRM that simply is not the case as the last has indicated by saying that the hydrological cycle is influenced-and so are all sorts of other climate variables such as loss of glacial, sea level rise (due to heat uptake and ice-melting), precipitation, storm tracks, climate extremes and more. Indeed, I'm for mitigation as well to address ocean acidification, but suggesting one does not do SRM because it does not address ocean acidification is like saying to a person injured in an accident that one does not try to help on severe bleeding because the person also got a concussion and I cannot address that as well. [Michael MacCracken, United States of America]</td>
<td>Rejected. Lack of impact on ocean acidification needs to be mentioned.</td>
</tr>
<tr>
<td>16463</td>
<td>89</td>
<td>55</td>
<td>89</td>
<td>90</td>
<td>It is stated that it does not address ocean acidification. But sulfur particles that fall in SRM would have an effect to increase the acidification. This aspect must be included as an impact of SRM [Elenita Darbo, Philippines]</td>
<td>Noted. Please indicated a possible relevant reference on this point. Other publications that were suggested by another reviewer (number 13471) were added.</td>
</tr>
<tr>
<td>15701</td>
<td>90</td>
<td>1</td>
<td>90</td>
<td>1</td>
<td>It is stated that it does not address ocean acidification. But sulfur particles that fall in SRM would have an effect to increase the acidification. This aspect must be included as an impact of SRM [Elenita Darbo, Philippines]</td>
<td>Noted. Please indicated a possible relevant reference on this point. Other publications that were suggested by another reviewer (number 13471) were added.</td>
</tr>
<tr>
<td>15453</td>
<td>90</td>
<td>1</td>
<td>90</td>
<td>1</td>
<td>It is stated that it does not address ocean acidification. But sulfur particles that fall in SRM would have an effect to increase the acidification. This aspect must be included as an impact of SRM [Elenita Darbo, Philippines]</td>
<td>Noted. Please indicated a possible relevant reference on this point. Other publications that were suggested by another reviewer (number 13471) were added.</td>
</tr>
</tbody>
</table>
1100 90 3 90 3

The report notes "the lack of testing of proposed schemes" and class Schaller 2013. This is a valid and essential point to explore, however, the possibility for experimental research to reduce the scientific uncertainty in the risks and efficacy of a potential deployment of geoengineering has advanced well beyond the early work. The discussion of this possibility has advanced both in terms of exploring the viability of research on natural analogs and deliberate perturbative experiments, and in the governance and ethics of such experimental proposals. Both national scientific institutions (National Research Council, 2009) and individual investigators (Keith et al. 2014; Robock et al. 2015; Lenferna et al. 2017) have contributed to this discussion. There has been minimal activity to date in pursuing these experimental investigations, their discussion is significantly more advanced and richer than what is reflected in the current text. [National Research Council. (2015). Climate Intervention: Reflected Sunlight to Cool Earth, National Academies Press; Shepherd, G. (2009). Geoengineering the climate: science, governance and uncertainty, Royal Society; Keith, D. W., Duron, R., & MacCracken, D. G. (2014). Field experiments on solar geoengineering: report of a workshop exploring a representative research portfolio. Phil. Trans. R. Soc. A, 372(2031), 20140175; Robock, A., MacCracken, D. G., Duron, R., & Christensen, M. W. (2015). Studying geoengineering with natural and anthropogenic analogs. Climatic Change, 132(1-2), 445-458; Lenferna, A., Rosado, R., Tan, A., Gardner, S., & Ackerman, T. (2017). Relevant Climate-Response Tests for Stratospheric Aerosol Injection: A Combined Ethical and Scientific Analysis. Earth's Future [Joshua Horton, United States of America]

Revised. The comment itself shows that results are uncertain (supporting what we have already mentioned). The studies cited point to model uncertainties and cannot provide the full picture to assess impacts on ozone depletion robustly.

11059 90 3 90 4


16464 90 3 90 8

Responses in turn: (1) Indeed, one cannot really test a sudden large scale SAI intervention, but large volcanic injections are quite analogous and if we improve our models by testing versus volcanic eruptions and conduct some small scale field experiments to better understand some particular processes like particulate formation, we likely have a pretty good prediction system for what will happen, and if faced with the option of not addressing some large-scale emergency situation, I'd choose relying on the models. And for SAI implementation, that is aimed at offsetting the shortwave heating spike in SIR, we have small volcanic eruptions as analogous situations for testing our models, and the overall process can be iterative and adjusted as the phasing up goes on. Thus, I think the first risk is greatly overestimated and not nearly strong enough to convince me that we do nothing. More: I think more than mitigation (which I certainly prefer) to limit the large-scale global warming and associated very significant impacts. After all, on our present course, we have come to accept that we need to change over our whole global energy system, so we do not contradict ourselves in our models: regarding their representation of climate states very unusual compared to the present as opposed to the GHG plus SIR simulations that have climatic conditions quite a bit more severe then is likely compared to and likely model well. (2) The recent papers on ozone perturbations by Times et al. do not show a large ozone influence—the reference needs to be updated—especially compared to the significant alleviation of harmful environmental and societal impacts that would be moderated. So, again, context is needed. (3) Of course SIR modifies the troposphere—that is the whole idea. What the model results show is that SIR brings the climate back much closer to the unaltered state as compared to the situation without SIR. This is a vague and really strange criticism that needs to be evaluated in context of what is being accomplished. (4) Again, the question is whether the impacts on crops are worse or better for elevated GHG with or without SIR. The studies I have seen suggest that the consequences of 4 times CO2 without SIR would be much, much worse than for 4 times CO2 with SIR—-that is the comparison that matters. There are no proposals to replace mitigation by SIR and no one is suggesting that SIR replaces mitigation. The studies I have seen suggest that the consequences of 4 times CO2 without SIR would be much, much worse than for 4 times CO2 with SIR—-that is the comparison that matters.

Revised. The comment itself shows that results are uncertain (supporting what we have already mentioned). The studies cited point to model uncertainties and cannot provide the full picture to assess impacts on ozone depletion robustly.

15702 90 4

The associated of ozone layer is not “potentially” if deployed, it’s certain, as the mentioned study affirms. Delete “potential” and the sentence that says “remains very uncertain”. This is one of the clearest dangers of SIR. [Eaarda Dahl, Philippines]

Accepted. Rephrased.

15454 90 4

The associated of ozone layer is not “potentially” if deployed, it’s certain, as the mentioned study affirms. Delete “potential” and the sentence that says “remains very uncertain”. This is one of the clearest dangers of SIR. [Eaarda Dahl, Philippines]

Accepted. Rephrased.

16465 90 6 90 7

Indeed, the evaluation needs to be made considering the potential to meet other sustainable goals, and the impacts of 2 or 4 times CO2 or other high GHG levels are much less severe if SIR is used along with all possible mitigation than if only mitigation efforts are completed. [Michael MacCracken, United States of America]

Revised. Given the potential side effects of SIR, we don’t know if the impacts will be less severe if SIR is used, particularly not in context of the Sustainable Development Goals.

14139 90 10 90 15

The combination of ocean acidification and consequences for marine ecoystems needs to be included. [Elena Polascumaci, Germany]

Accepted. This point is included in the revised text.

16466 90 12

The phrasing “with respect to the water cycle” is clear from the note that SIR reduces the hydrological cycle with respect to 4 times CO2. Well, of course, but how do the crops do with the climate of 4 times CO2 with the hydrological cycle interfered from the present. The assessment needeed is more appropriately how agriculture and food production, etc. would do in a world with 4 times CO2 without SIR versus 4 times CO2 with SIR. It is really essential that a rewrite makes sure it is comparing what is appropriate to be comparing. [Michael MacCracken, United States of America]

Accepted. This point is included in the revised text.
Again and again the wrong comparison seems to be done, at least when using SAI as a supplement to mitigation rather than as an alternative to it. The impression of many in the area is that the SAI technology could be applied by a factor of many before the baseline (this is what we are being discussed). The appropriate comparison is elevated GHG with or without SAI, so a climate that is strongly perturbed versus a climate that is much less perturbed, if not quite perfectly the baseline case. [Michael MacCracken, United States of America]

The report assigns a medium confidence (expert judgement) to the statement that “the risks of SAI deployment for global food security and ecosystem health would outweigh the benefits”. This assignment gives a misleading impression of the state of knowledge about SAI’s impacts in these areas. According to IPCC’s guidance to authors, “medium confidence” implies at least medium agreement with medium evidence regarding the issue [Mastrandrea et al., 2010]. However, due to the limited research results in these area and the lack of agreement on this topic (as reviewed above), these criteria do not appear to be satisfied. In addition, the use of the term “expert judgement” without further explanation or reference to existing studies undermines confidence in this characterization. We recommend more careful consideration in assigning this confidence level, and possibly removing it from the report. [Michael D. Mastrandrea et al., “Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties,” IPCC (2010)] [Joshua Horton, United States of America]

See comment 16 above. The problem with the termination-shock argument is that termination shock locks hazardous terrain in unhealthy states for many decades. [Christopher Monaghan, United States of America]

According to IPCC’s guidance to authors, “medium confidence” implies at least medium agreement with medium evidence regarding the issue [Mastrandrea et al., 2010]. However, due to the limited research results in these area and the lack of agreement on this topic (as reviewed above), these criteria do not appear to be satisfied. In addition, the use of the term “expert judgement” without further explanation or reference to existing studies undermines confidence in this characterization. We recommend more careful consideration in assigning this confidence level, and possibly removing it from the report. [Michael D. Mastrandrea et al., “Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties,” IPCC (2010)] [Joshua Horton, United States of America]

The section on termination shock (p. 90) could be a bit better organized: First, the cause of the termination shock could be better explained, especially its connection to the continued accumulation of GHGs in the atmosphere during SAI deployment. Second, the second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]

The second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]

The section on termination shock (p. 90) could be a bit better organized: First, the cause of the termination shock could be better explained, especially its connection to the continued accumulation of GHGs in the atmosphere during SAI deployment. Second, the second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]

The section on termination shock (p. 90) could be a bit better organized: First, the cause of the termination shock could be better explained, especially its connection to the continued accumulation of GHGs in the atmosphere during SAI deployment. Second, the second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]

The section on termination shock (p. 90) could be a bit better organized: First, the cause of the termination shock could be better explained, especially its connection to the continued accumulation of GHGs in the atmosphere during SAI deployment. Second, the second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]

The section on termination shock (p. 90) could be a bit better organized: First, the cause of the termination shock could be better explained, especially its connection to the continued accumulation of GHGs in the atmosphere during SAI deployment. Second, the second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]

The section on termination shock (p. 90) could be a bit better organized: First, the cause of the termination shock could be better explained, especially its connection to the continued accumulation of GHGs in the atmosphere during SAI deployment. Second, the second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]

The section on termination shock (p. 90) could be a bit better organized: First, the cause of the termination shock could be better explained, especially its connection to the continued accumulation of GHGs in the atmosphere during SAI deployment. Second, the second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]

The section on termination shock (p. 90) could be a bit better organized: First, the cause of the termination shock could be better explained, especially its connection to the continued accumulation of GHGs in the atmosphere during SAI deployment. Second, the second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]

The section on termination shock (p. 90) could be a bit better organized: First, the cause of the termination shock could be better explained, especially its connection to the continued accumulation of GHGs in the atmosphere during SAI deployment. Second, the second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]

The section on termination shock (p. 90) could be a bit better organized: First, the cause of the termination shock could be better explained, especially its connection to the continued accumulation of GHGs in the atmosphere during SAI deployment. Second, the second paragraph should be brought up to line 30, so as to clearly explain the conditions under which termination shock would occur and the ways that it could be avoided. Third, the second half of the first paragraph (beginning with “Jones et al. (2013) examine changes”) should be moved to a separate paragraph. [David Morrow, United States of America]
In Muri et al. (2017) we show that the carbon cycle reverts quickly back to the baseline state after sudden termination of large-scale SRM (SAI, MCB and CCT). We have done the G4 experiment with NorESM too. If you want the data, please e-mail helene.muri@geo.uio.no. Or I can do the calculations for you. Alex and Mercardo: Eliseev - combine them into one

This sentence does not make sense. Also, this paragraph should mention that other aerosols have different optical properties; some would lower the albedo of the Earth. Again, please provide context. The GHG with SRM likely causes much smaller impacts than elevated GHG without SRM, and this needs to be noted and emphasized when the SRM text is being revised.

It is nice to have a paragraph all on one study. Happen to be an author of, but I think this is too much detail and not enough of an assessment to say how relevant to 1.5°C. Many other paragraphs have a similar issue. Simply saying the MCB will reduce PV by 1% is misleading if you don’t know the scenario. I just picked on this example, but the rest of the box also has this problem [Paul Fronter, United Kingdom (of Great Britain and Northern Ireland)].

The 4.5% figure does not seem to appear in Smith et al. 2017. I think it should be made clear that the 5.9% figure is for CSP, not PV. PV losses in Smith et al. are considerably lower. I think it might be helpful to readers to point out that global installed CSP capacity is around 5 GW, while installed PV capacity is around 300 GW [Oliver Morton, United Kingdom (of Great Britain and Northern Ireland)].

This first sentence in this paragraph that SRM would be beneficial to sustainable development is directly contradicted and undermined by the succeeding sentences that present the many potential risks and impacts of SRM, including inequality, captivity, ozone depletion, etc. The first sentence therefore needs to be reformulated to state the risks posed by SRM on sustainable development, to be consistent and coherent with the rest of the paragraph. [Mariah Dacho, Philippines]

Please change "cheap" to "lower cost" or "less expensive." Also note that SRM does not just bring down global temperatures, it reduces warming and other changes in climate over the whole Earth—yet SAI appears to do this. SRM counters climate change, not just temperature. [Michael MacCracken, United States of America].

Noted, but paragraph deleted

Accepted, text revised

Second, the text appears to deprecate the costs of climate change vis-a-vis the costs—so direct and indirect—of SRM. In short, SRM, in isolation, is costly. Direct costs might be cheap, e.g., when calculated per KGW [Keith, Wagner, and Zaeli 2017], but SRM is not free. Indirect costs might be high in absolute terms, but those absolute costs have to be seen in comparison to reference climate scenarios. Costs of RCP 8.5 and even 4.5 are vast. See, for example, Delong et al. 2013 for U.S. costs alone; see also, Hsiang, Burke, and Miguel 2013 for an example of non-monetary costs. SRM will not compensate any of these costs perfectly, but that is not the only relevant comparison. Absolute costs seen in isolation only mislead and confuse [Keith, Wagner, and Zaeli 2017].

Accepted, replaced cheap with lower cost and lower impact compared to damages or costs of mitigation

Noted, Comment now in 1.6

Noted. Accepted. Urban box shifted to Chapter 5

Taken into account, this box now addresses SRM only in overshoot and related to 1.5°C scenarios.
The report does not accurately represent the state of knowledge regarding impacts of SAI on stratospheric ozone, or the implications for human health. The report states that “SAI...may increase health effects of ozone depletion.” This is misleading, and reflects a tendency for selective and incomplete literature review. [Joshua Horowitz, United States of America]

The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Erick Pajares, Peru]

This is a fair criticism—that it will not end all consequences from the higher concentrations of CO2/GHGs and might instead be blamed for not doing everything. This is the same problem of applying a tourniquet to stop rapid bleeding—one may save a person’s life but they may lose that arm or leg, and in that the risk from not using the tourniquet is not available to that person, they have to rely on the tourniquet to the risk that the tourniquet might not be effective. The argument convinces them that this is the case. As I commented once (wryly) on this matter at a briefing on geoengineering at the Papal Academy of Science, the public’s view might be that with SRM there should be no further acts (or events) attributable to God (or natural variability)....a decision is made to move ahead with SRM, the public (might)reason might well be that the climate engineers should be able to present all extreme conditions, and high, of course, would simply not be the case—at least certainly not the case for use of global SA. With much improved predictions, however, it might be possible, with considerable effort, to do a bit of moderation of seasonal extremes over large areas, etc., for example, marine cloud brightening and other approaches that are based on modifying tropospheric phenomena given the much shorter lifetime of the injected materials that tend to enhance cloud brightness. With respect to the preparation of SRM, I think this issue deserves more coverage and discussion, with less distraction on what I consider the lesser issues covered in the preceding sentence. [Michael MacCracken, United States of America]

The report does not accurately represent the state of knowledge regarding impacts of SAI on stratospheric ozone, or the implications for human health. The report states that “SAI...may increase health effects of ozone depletion.” This is misleading, and reflects a tendency for selective and incomplete literature review. [Joshua Horowitz, United States of America]

This is a fair criticism—that it will not end all consequences from the higher concentrations of CO2/GHGs and might instead be blamed for not doing everything. This is the same problem of applying a tourniquet to stop rapid bleeding—one may save a person’s life but they may lose that arm or leg, and in that the risk from not using the tourniquet is not available to that person, they have to rely on the tourniquet to the risk that the tourniquet might not be effective. The argument convinces them that this is the case. As I commented once (wryly) on this matter at a briefing on geoengineering at the Papal Academy of Science, the public’s view might be that with SRM there should be no further acts (or events) attributable to God (or natural variability)....a decision is made to move ahead with SRM, the public (might)reason might well be that the climate engineers should be able to present all extreme conditions, and high, of course, would simply not be the case—at least certainly not the case for use of global SA. With much improved predictions, however, it might be possible, with considerable effort, to do a bit of moderation of seasonal extremes over large areas, etc., for example, marine cloud brightening and other approaches that are based on modifying tropospheric phenomena given the much shorter lifetime of the injected materials that tend to enhance cloud brightness. With respect to the preparation of SRM, I think this issue deserves more coverage and discussion, with less distraction on what I consider the lesser issues covered in the preceding sentence. [Michael MacCracken, United States of America]

The text states that “SAI ... may increase health effects of ozone depletion.” This is misleading, and reflects a wider tendency for selective and incomplete literature review. [Alan Robock, United States of America]

Note: removed the part of the sentence on ozone and health.

Noted: Thank you for that clarification. It would be helpful if you could provide specific examples or studies that support your argument. [Helene Muri, Norway]

Noted: we are space constrained for a longer discussion but we now state “SRM like many other forms of climate response requires multilateral governance”. Please Note that all discussion about “Governance, public perception and ethics of SRM” moved to section 4.3.9. due to space limitations of the Box.

Accepted: added references as appropriate. Please Note that all discussion about “Governance, public perception and ethics of SRM” moved to section 4.3.9. due to space limitations of the Box.

Note: added references as appropriate. Please Note that all discussion about “Governance, public perception and ethics of SRM” moved to section 4.3.9. due to space limitations of the Box.

Noted: The principle of intergenerational equity (Eq), the right to the future and the rights of future generations (human and non-human species, principle of interspecies justice) must be deeply analyzed considering the implications of possible solar radiation management (SRM) policies. [Erick Pajares, Peru]

Accepted: Comment and references added. Please Note that all discussion about “Governance, public perception and ethics of SRM” moved to section 4.3.9. due to space limitations of the Box.

Note: the current text about public participation and public perceptions here and elsewhere in the chapter is incomplete. It should not discuss only work that paints publics as ignorant and confused. Publics can also be productively engaged in governance—indeed, should be thus engaged to ensure more robust governance. Please Note that all discussion about “Governance, public perception and ethics of SRM” moved to section 4.3.9. due to space limitations of the Box.

Note: noted and thank you. At least one of the papers you are referring to is: Stilgoe, J., et al. (2013). “Developing a framework for responsible innovation.” Research Policy 42(9): 1568-1580; Macnaghten, P. and R. Owen (2011). “Environmental science: good governance for geoengineering.” Nature 479(7373): 293-293 - work which questions the governability of the technology in democratic manner. The discussions in this literature of the kind of socio-political systems that are compatible with SRM technology needs to be reviewed and engaged. [Michael Thompson, United States of America]
The biogeography entry for IPCC 2014 should have the title as “Climate Change 2014: Impacts, Adaptation, and Vulnerability” if intending to refer to both Parts A and B of the AR5 WGII report. Right now it just refers to Part B. [Wilfran Moufouma Okia, France]

18365 94 94 Accepted, editorial

9035 93 35 93 37 Comment response to the comment, but the key thrust to the text is supported by the literature cited

1223 93 40 100 54 Accepted

9396 93 35 93 37 Comment response to the comment, but we are unable to provide such extensive discussion in a short report. Perhaps AR6 can consider this when there is more literature to cite

5740 93 40 93 40 Accepted - A ‘life’ has been added

16479 94 6 94 6 Accepted

16480 94 9 94 9 Accepted

16481 94 11 94 11 Accepted

16482 94 18 18 18 Accepted - wording changed, noting the literature has expanded rapidly since AR5 which was over 12 yrs ago

18885 94 41 94 47 Accepted - editorial

14112 94 1 Accepted, specific case studies are discussed

The section contains too many generalised statements that are about SIDS, and not specific to the Caribbean (islands). In general, this section should also highlight the diversity of Caribbean Island geographies and various cultures and histories addressing the various challenges and opportunities.

[Enrico Pinchera, Germany]
The key risk and vulnerabilities section does explicitly not mention the link between hurricanes and climate change. Also the computing risks of sea level rise and increased storm intensity (and thus storm surge) should be included, along with associated impacts (e.g. p. p. p. coastal infrastructure and water resources. This section could also discuss barriers to adaptation (and in particular impacts that cannot be adapted to) - making clear the differences in costs of adaptation vs. damages (and the different funder’s funding channels of the associated funds) is important for making the case for adaptation. (Michel Scherfetter, Netherlands).

Recent events seem to be raising a question whether this thinking in averages makes sense-the phrase on large variations helps, but I still more attention to this point is needed. Particular hurricanes (and cyclones in the Pacific) hit particular nations and can, as recently illustrated, virtually wipe out the economies of particular island nations in ways that will likely take generation to ready recover from. In different years, it will be different hurricanes that wipe out different islands. To be talking about such experiences in terms of averages just does not seem to do justice to what will be happening in the region (and other regions) as the likelihood of hurricanes becoming very strong is headed up. I think some modification is needed in the text that makes clearer that particular nations may well get wiped out and that use of averages really obscures the tragedies likely to keep occurring—and become more frequent (also for many Central American nations and for the US, etc.) (Michael MacCracken, United States of America).

Betzold 2015 is a summary paper on SIDS and not adequate to describe the particular case of the Caribbean. There is a wide range of case specific

Smajgl et al. 2015 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

Pitmann et al. 2015 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

Renaud et al. 2014 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

TSU needs a copy of the Guerra 2017 reference—hard to find [Wilfran Moufouma Okia, France] Accepted, already sent and uploaded to Mendeley

Renaud et al. 2014 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

Gass et al. 2011 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

Smith et al. 2013 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

Again, here Betzold mainly summarises from examples in the Pacific and Indian Ocean. This reference is not adequate to describe how seawalls are

Sebesvari et al. 2017 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

Also the lack of resources for enforcement of adaptation measures, building codes, protection from sand mining, etc. is a problem. [Elvira Poloczanska, Germany]

Gass et al. (2011) not linked to Mendeley [Wilfran Moufouma Okia, France] Accepted, editorial

Zanzanaini et al. 2017 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

Chapman and Darby 2016 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

Schipper et al. 2010 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

ICEM 2013 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

Sebesvari et al. 2017 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial

Schipper et al. 2010 needs a Mendeley link [Wilfran Moufouma Okia, France] Accepted, editorial


Comment: Add information from Grafalokos et al., 2018 (In Press). Other chapters in Climate Change and Cities: Second Assessment Report of the Urban Climate Change Research Network also provide detailed information on adaptation measures, implementation gaps and challenges, and adaptation mechanisms. [Cynthia Rosenzweig, United States of America]

Response: Accepted

Comment: Taken into account, there is a specific cities box in the SR

Response: Accepted, editorial

Comment: Do Not Quote, Cite, or Distribute Page 158 of 159

Response: Do Not Quote, Cite, or Distribute Page 158 of 159
### IPCC WGI SR15 First Order Draft Review Comments And Responses - Chapter 4

<table>
<thead>
<tr>
<th>Comment No</th>
<th>From Page</th>
<th>From Line</th>
<th>To Page</th>
<th>To Line</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>15642</td>
<td>43295</td>
<td>5</td>
<td>43295</td>
<td>5</td>
<td>Add: &quot;...philosophical evidence indicates that the opposite effect might also be true (Merk et al., 2016); (Merk, C., Pfister, G., &amp; Rehdanz, K. (2016); Knowledge about aerosol injection does not reduce individual mitigation efforts. Environmental Research Letters, 1(1), 264019; Matthias Honegger, Germany)&quot;. Accepted, reference added, text revised.</td>
</tr>
<tr>
<td>15643</td>
<td>43295</td>
<td>22</td>
<td>43295</td>
<td>22</td>
<td>The point here is that the scale (i.e., pace) has been observed historically. This scale has.</td>
</tr>
<tr>
<td>15644</td>
<td>43295</td>
<td>45</td>
<td>43295</td>
<td>45</td>
<td>Add: &quot;...but there are only few examples of effective policies deliberately affecting reductions in meat consumption and more trial and error approaches may be necessary to advance effective policies to limit consumption of meat and other highly carbon intensive food products.&quot; (Matthias Honegger, Germany)&quot;. Accepted, text revised to take this comment into account. The statement on unilateral action is removed.</td>
</tr>
<tr>
<td>15645</td>
<td>43295</td>
<td>11</td>
<td>43285</td>
<td>11</td>
<td>The formulation that costs of DACS &quot;seem high so far&quot; by contrast to the previous discussion of BECCS implies that the cost of BECCS is not high, which is debatable claiming a cost-range of BECCS from 200-2000$/tCO2 stored and since BECCS has not been utilized as a mitigation option at scale to date. (Matthias Honegger, Germany)&quot;. Accepted, text revised to remove the phrase &quot;seem high so far&quot;.</td>
</tr>
<tr>
<td>15646</td>
<td>43295</td>
<td>13</td>
<td>43285</td>
<td>13</td>
<td>Add: &quot;...and more research and development is needed to improve their potential cost-effectiveness, determine their respective mitigation potentials and likely implications on sustainable development, where they deployed at Gt-scales annually&quot; (Matthias Honegger, Germany)&quot;. Rejected, the statement was already prescriptive, and was removed for this reason. This addition would make it even more prescriptive as it is asking for more R&amp;D.</td>
</tr>
<tr>
<td>15647</td>
<td>43285</td>
<td>16</td>
<td>43285</td>
<td>18</td>
<td>This statement directly contradicts the most fundamental understanding of physics and every physical evidence and research that I know of as well as line 38 on page 3-127 of this draft report. Global average temperature is pretty much the only variable on which one can predict with certainty the effect of SRM (i.e. in theory SRM could compensate any level of warming due to elevated GHG concentrations). Whether this could be done in a way that would be beneficial is not a different question altogether. I therefore propose the following formulation: &quot;Full compensation of temperature increases corresponding to elevated GHG concentrations via SRM would result in an imperfect reversal of change in most climate variables. Modelling evidence suggests that deployment of SRM to partially mask warming or to slow its pace, might result in a more adequate result with regard to changes in precipitation patterns and other climate variables.&quot; (Matthias Honegger, Germany)&quot;. Rejected, the statement was already prescriptive, and was removed for this reason. This addition would make it even more prescriptive as it is asking for more R&amp;D.</td>
</tr>
<tr>
<td>15648</td>
<td>43285</td>
<td>18</td>
<td>43285</td>
<td>20</td>
<td>This statement on moral hazard is one-sided and does not reflect for the rich academic discussion and empirical evidence to the contrary effect. In a lot of the published research addressing moral hazard &quot;negative moral hazard&quot; has been found, indicating strengthened support for mitigation action upon being presented with the possibility of SRM. If the executive summary is to mention this issue, it should account for this (overwhelming) evidence! At this point the issue of &quot;moral hazard&quot; remain an unanswered one that requires continued attention in research (Matthias Honegger, Germany)&quot;. Accepted, reference added, text revised.</td>
</tr>
<tr>
<td>15649</td>
<td>43285</td>
<td>22</td>
<td>43285</td>
<td>22</td>
<td>The statement &quot;making it socially available&quot; is not understandable. What does &quot;it&quot; refer to, and what does the sentence try to accomplish? Is it about the issue of unilateral action? If so, its now clear, and is not a sentence of potential unilateral deployment! (Matthias Honegger, Germany)&quot;. Accepted, reference added, text revised.</td>
</tr>
<tr>
<td>15650</td>
<td>43285</td>
<td>53</td>
<td>43285</td>
<td>53</td>
<td>Incomparable statement &quot;carbon neutral and carbon negative...&quot;. If we do not start to incorporate policy planning for negative emissions at all levels, we need to urgently review the pathways against which we measure feasibility of 1.5 to 2°C (meaning decarbonization would need to happen in the 2020's if we can't assume negative emissions)! This is a very serious issue! (Matthias Honegger, Germany)&quot;. Accepted, reference added, text revised.</td>
</tr>
<tr>
<td>15651</td>
<td>43316</td>
<td>3</td>
<td>43316</td>
<td>3</td>
<td>Add sentence: &quot;Market mechanisms for mitigation can help limit mitigation cost including for novel approaches to remove CO2 from the atmosphere. This has the potential to enable countries to engage in commitments for deeper mitigation ambition including net-negative mitigation targets and as a result in an increased likelihood to reach the 1.5°C target of the Paris Agreement (4.4.7) (Matthias Honegger, Germany)&quot;. Rejected, there is no evidence for this particular point in the chapter. The literature on this is also limited and sketchy.</td>
</tr>
<tr>
<td>15652</td>
<td>43316</td>
<td>16</td>
<td>43316</td>
<td>16</td>
<td>Add sentence: &quot;This includes in particular a need for substantial research and development programs for new technologies, which may only exist at pilot scale or as concepts, to advance their cost-effectiveness and their potential for large scale application such as in case of technologies that ought to result in negative emissions such as BECCS or DACS.&quot; (Matthias Honegger, Germany)&quot;. Rejected, this would introduce policy prescriptiveness.</td>
</tr>
</tbody>
</table>