Expert and Government Review Comments on the IPCC WGIII AR5 Second Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
34183	7					The list in the first paragraph misses the whole point of mining emissions. Here we have all kinds of waste gas streams like from coal mining and associated gas the is flared. Also there is a lot of transmission losses in pipelines. Moreover, LNG liquefaction plants could partly run on renewables in regions with huge solar and/or wind potential. The advantag is also that LNG ports are naturally at harbors where there is much wind.	Accepted - fugitive emissions are now taken into a account.
34161	7					The table is confusing and it is not useful to require the reader to understand it. Also, it is not clear what such a detailed table adds to the assessment of the energy system for climate change mitigation. A more agrgregate perspective and also a visual representation should be developed by the authors. It would also be useful to comprise the energy amounts and the emission amounts (CO2 only) in a single exhibit.	Rejected. The IEA energy balances are in wide use for decades. So, expert community is already accustomized in using those tables. For those readers who are not familiar with energy balances tables, the reference is given where more detailed explanations may be found.
34171	7					Use GtCO2 instead of GtC, because also other information (e.g. Chapter 6) is given in the CO2 units. This increases readability and comparisons between the chapters.	Rejected: Use of CO2 and C mass units is commonly done and conversion readily achieved.
34176	7					Please make clear what the conditions for the recoverability of those quantities are. Please also emphasis the tha 'above ground' factors are largely irrelevant for these quantities.	Rejected: Space does not allow for the requested level of detail in the discussion. These points are taken up in the cited papers.
34166	7					I do not think that it is a good idea to have total changes of energy use at the global level with the same scale as the regional changes. The regional shares are given by the numbers in the figure anyways. Also the red triangles do not add much information. What is much more important is to combine the energy issue with the CO2 emissions (and maybe also the GHG emission) issue that is related to the energy sector changes. This would really addd information that is relevant or the policy makers.	Rejected. This allows it to illustrate regional contributions to global increments. This is an important message to be delivered by this figure
34192	7					It is hardly possible to read this graph. Hence, it is also not possible to review it.	Accepted. Changes made.
34193	7					The meaning of the figures is unclear. There is no scale at all and therefore I do not know what I am seeing.	Noted. These charts show shares, which are scale free. The description of the figures in in the figure caption.
34169	7					The CLAs are recommended to check the consistency of the two sub-plots. At a first glance it makes no sense to me, why the ratio TPES/FEC should have any meaning as a component to explain total changes in emissions from the energy sector. Also the sub-plot on the right hand side misses the units on the y-axis. An information that would be interesting to know, is how much CH4 is contributing to the total in the large sub-plot.	Noted. Was fixed.
34170	7					The colormap is not clear because the orange/sand like colors are too close to each other.	Noted. Was fixed.
34182	7					Are these numbers based on gross electricity production or net of own energy consumption e.g. for the water pumps in the steam cycle etc.	They are based on net electricity production, as is common in LCA.
34262	7					please see attached file through the email: comments@ipcc-wg3.de	Noted - unfortunately the attached file could not been located.

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34786	7					I think a defintion of what is considered as "water consumption" should be added. For hydropower I think you assumed that water consumption refered to evaparation in reservoirs? UNESCO-IHE, Octobre 2011, Accounting for water scarcity and pollution in the rules of international trade, research Report Series No. 54, Editors: A.Y. Hoekstra, M.M. Aldaya, B. Avril ; Authors: J. Granit and A. Lindström, Stockholm International Water Institute, Stockholm, Sweden "Opposing perspectives on the extent to which water is “consumed” during its use for energy production, and in particular during its use for hydropower production, have resulted in a wide range of estimates on the topic. In the case of hydropower, different production technologies such as run-off-the-river plants use no or relatively small water reservoirs. When water is stored in reservoirs, however, some water will be consumed due to evaporation. How much water that is consumed depends on several factors, such as the surface area and depth of the reservoir and local climate conditions (Glennie et al., 2010). References on water consumption in hydropower production display the broadest range of consumptive values amongst the different power producing technologies presented in this paper varying from negligible amounts of water consumed to values above 200 m3/MWh (IPCC, 2011F). Reservoirs for hydropower are often used for multiple purposes and consumption related to other uses is difficult to distinguish in the existing data. This means that the figures on consumptive water use for hydropower might be considerably less then what is often reported (Ibid)."	Noted. I think here water throughflow is mixed up with water use for cooling. Sure, both technologies could use air cooling, but we do not apply this today for fossil technologies which also have a water use problem, but somewhat smaller than CSP and hydro
34787	7					Please also add positive impacts of those technologies (only negative ones are mentioned). For instance hydropower provides additional services than pure power generation: flood/draught control, ancillary services, fisheries, navigation, drinking/potable water, etc.	Accepted. Has been added.
34779	7					Add that methodologies are different from technical potential estimation as it was presented in IPCC SRREN 2011. For most of those RE technologies its is a top down approach, except for hydropower as it is a bottom-up approach (i.e. site approach). This difference should be highlighted to compare those values between RE technologies.	Rejected - the figure and related text already note that different methodologies are used across technologies and across studies, and space constraints do not allow for a full enumeration of those differences in this section of Ch 7. Those details will need to be left for the underlying SRREN citation, due to space constraints, but the text of the chapter already at least noted generally that differences do exist.
34785	7					Value provided GHG emissions for hydropower are strange … What is the source of this figure? My prosposition is to use the figure provided by SRREN report on that matter (ref. SPM 8 in the summary for policy makers). Why to add new figures?	Taken into account. Figure has been updated. The point of this report is to update findings, not reproduce old ones.
31441	7					General comment: We think that the use of the highly potent greenhouse gas SF6 in high voltage appliances, such as gas insulated switchgears, should be addressed in this chapter.	Rejected - space constraints do not allow to go into such details.
29967	7					These are the main mitigation options for electricity - other options are most appropriate in other parts of the energy sector (e.g. electrification of heat or hydrogen for transport).	Accepted - electrification now is mentioned.Hydrogen is treated in chapter 8 (transport).
30186	7					Cross reference to p11, line 31 (to end of page) and p. 24 line 44 - which states RE accounted for 'almost half' of new electricity capacity added in 2011; this is also corroborated in XY and is strategic in that it illustrates substantive change at the margin.	Accepted- text and the ES now emphasizes this.

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20467	7					A discussion about the possible conflicts between CCS and fracking for unconventional oil or gas and the need for a comprehensive management is missing despite various studies exist, e.g. T. R. Elliot and M. A. Celia, Potential Restrictions for CO2 Sequestration Sites Due to Shale and Tight Gas Production, Environ. Sci. Technol., 2012, 46 (7), pp 4223–4227	Accepted. This point has been included in the paragraph about the need for proactive basin-scale management within Section 7.5.5.
20468	7					Compared to the actual status of the technology, the description of CCS technology is far too detailed and offers room for shortening the chapter as required.	Accepted: Section 7.5.5 has been shortened and significantly reworked to improve clarity and readability.
20494	7					1) Please update with 2012 numbers 2) It would be better to compare PV system prices with power plant prices. Of course another possibility is to compare component costs like PV module prices with turbine prices.	Taken into account - comment is obsolete as underlying figure has been deleted.
26624	7					Challenge for "Usage" of CO2 for may be refered to; http://www.cslforum.org/publications/documents/perth2012/tg_CO2UtilizationOptionsTFPhase1Report.pdf	Rejected. The comment is unclear.
24403	7					Enhanced geothermal systems should be included because of their very large resource potential and their ability to provide baseload power.	Accepted - figure layout changed.Cost data were updated by using a considerably increased number of sources.
23751	7					The C Change impact on food and feed will be probably similar, but the reliance on food is much more than on biofuels. This could be added in the discussion.	Rejected - other chapters of the IPCC report (as well as the WGII report) provide greater coverage of biofuel and biomass issues, and are a better location for expanded discussion of these issues. Ch 7 focuses exclusively on matters of energy supply.
26875	7					It seems odd that nuclear is mentioned in this FAQ as most of the co-benefits cited are particular to RE, whereas the risk of proliferation is exclusive to nuclear.	Rejected - The co-benefits of reduced air pollution, local employment opportunities, better energy security, and, to some degree, reduced vulnerability to price volatility (fuel cost is not as significant for nuclear as it is for other sources) all apply to nuclear.
33880	7					LCOE for geothemal shows a large range. The geotehrmal energy is site specific and cost depends data, education and expertise used in the project development.	Noted - the purpose of the range shown exactly is to highlight these differences.
19162	7					Already submitted detained comments.	Noted
19052	7					This seems to exclude unprocesed biomass and processed charcoal for household and non-household use. The transport means range from non-engine vehicle (headloading, bicyles and hand carts etc) to fossil fuel vehicles	Accepted -text revised accordingly
23610	7					Colors of the bars are altered by the green background in the right hand side part of the figure	Accepted. Figure revised.

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23306	7					Suggest left column be : Nuclear replacing coal power; Renewable energy replacing coal and gas power; [no need to list all the RE sources]; CCS added to coal or gas power; BECCS replacing coal power; Fugitive methane and coalbed methane capture - use or treatment. [Coalbed methane missing at present]. Statement on biomass (column 3) is not relevant for residues and wastes. Hydro is dammed only- not run-of-river. Hydro doesn't consume water - normally diverts it over a short distance then replaces in river bed. Legal liability issues not included under CCS. Where does the reader find "see biomass co-benefits/risks"?	Taken into account. Doing a comparison between two technologies (nuclear vs. Coal) is already complicated in the context of this concise table, comparing nuclear to coal and gas would make the table unreadable. We added coal bed methane; this was meant to be included if not mentioned explicitly. Hydropower depends very much on the precise project, climatic and geographic conditions etc. However, water use is related to evaporation which can be very substantial.
25129	7		3	38	4	The range of GHG emissions from NG power plants with CCS in Figure 7.9 seem almost twice that in the text (Page 37, lines 3-4).	Accepted. Different sources and %ile ranges were used; this has now been harmonized.
33876	7		44			I am assuming that thetext means weakness (i.e., geothermal adds to polution); that is incorrect. Geothermal energy is arguably the cleanest baseload energy. The first study, with regard to CO2 emissions, has a number of tables that exlude geothermal as opposed to most other technologies, which might reflect a low sample size. The second study that pertains to water contamination is a single case study in Turkey (abstracts to these studies can be found here http://www.sciencedirect.com/science/article/pii/S016977220800137X , and http://www.sciencedirect.com/science/article/pii/S1364032110000638). The first study, with regard to CO2 emissions, has a number of tables that exlude geothermal as opposed to most other technologies, which reflects a low sample size. The second study pertains to water contamination is a single case study in Turkey. In the US, geothermal energy enjoys a solid track record due to development activities embedded within a proven regulatory/environmental framework. All renewable energy development has carries risks but, in this case, pollution the exception to the rule	Taken into consideration. The reviewer must have misunderstood the table. The CO2 benefit is acknowledged. We have modified the "other" column to make sure grid balancing concerns cannot be seen to affect geothermal energy. We have qualified water concerns to "some geothermal".
26869	7					For offshore wind there are also benefits to marine fauna.	Rejected. No reference provided.
20603	7					Cut by 15%.	Rejected - important information is provided in a concise way. Further cutting was not possible.
29972	7					An important barrier is the higher cost of delivering energy services using low-carbon technologies, which can make them unaffordable for large parts of a population while still being seemingly affordable for a country as a whole. This energy equity issue is an important barrier to investment for governments who do not wish to make energy unaffordable for large parts of the population. Energy equity issues are not considered by most energy system models.	Noted - High cost is a big barrier. This section deals with opportunities how to raise funds to invest in high-cost, but low-carbon energy supply technologies. Equity issues are discussed in Chapter 3.
20500	7					There is no reference to the fact that disel prices are subsidised widely in a lot of countries where it is used for rural electrification. There is the reference to the needed investments into RES, but not to the IEA subsidy report.	Accepted in part, Rejected in part- "removal of fossil fuel subsidies" is added in the text. Becasue of space limitation, the IEA subsidy report is not included.

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34189	7					The issue of carbon-lock in is also discussed in Pahle et al. Showing for the German power sector that the built up of infrastructure is not as serious as has been suggested as long as there is a competitive fringe that can take away profits from ologipolistic firms. Pahle M, Lessmann, K, Edenhofer O, Bauer N (2013) Investments in Electricity Markets with Imperfect Competition: Technology Choice and Optimal Carbon Pricing. Energy Journal, accepted for publication. See the attached document Pahle_Investments in imperfect electricity markets REVISION2.doc	Taken into account - The discussion of EFFECTIVE carbon lock-in has been adjusted: "Although such capital stock is not an irreversible investment, premature retirement (or retrofitting with CCS if feasible) is generally expensive. Furthermore, removal of existing fossil plant must overcome inertia from existing providers, and consider wider physical, financial, human capital and institutional barriers." A much broader discussion of inertia and lock-in is given in section 5.6.3 - this is now correctly cross referenced.
34190	7					The issue of carbon lock in is also discussed in Bauer et al. (2013) for emissions in the near term being hgiher than in an idealized setting. It turns out that mainly coal emissions tend to be too high and then depending on the flexiblity to induce early retirement the short term carbon lock in has a longer-term effect on the entire fossil fuel market. See the attached document TFS-S-13-00070_nofrontpage.pdf	Taken into account - See previous answer to comment by same review (comment 34189).
20604	7					Cut by 15%.	Accepted.
34195	7					The sub-section is dealing with the future pathways of the electricity sector, if various climate change mitigation targets shal be achieved. The sub-section looks at the technology level. The sub-section however is not clearly an assessment of technologies based on the available literature. Several studies based on models to assess the electricity sector and the various technologies are not mentioned here. The assessment of technologies goes only one step asking for the contribution of a technology to the total generation. The assessment does not ask how mportant several options are. This is however, particularly important for a policy relevant assessment of the power sector and the various technology options therein. To name just a view studies which looked into this issue are the RECIPE project, the ADAM project, EMF-27, AMPERE. With respect to paricular technologies the studies by Massetti and Ricci [http://dx.doi.org/10.1016/j.eneco.2013.02.012] on CSP as well as Bauer et al. [www.pnas.org/cgi/doi/10.1073/pnas.1201264109] on nuclear power should be considered by the authors.	Rejected - space constraints do not allow to go into the details of specific technologies.
34194	7					The Chapter is devoted to Energy Systems and sub-section 7.11.4 is focusing on the relationship between short term emission and long-term cliamte change stabilization policy interactions. The authors miss to mention the Study by Bauer et al. (2013) that pays particular attention to the fossil energy markets and how they are affected by various policy configurations of short-term emisison targets and long-term stabilization levels. The study clearly shows how such short term biases and distortions are amplified in the future, if stringent stabilization targets should be be achieved. Also the distributional consequences are assessed. The study applies results of the AMPERE model comparison exercise. The paper is added to this review TFS-S-13-00070_nofrontpage.pdf	Accepted. Citation added.
25625	7					This section seems to be biased to ETS side.GHG pricing policy does not necessarily mean tradable emission permits like ETS in Chapter 15 so that the expression should be reviewd to well ballanced one.	Accepted - other aspects like carbon taxes and feed-in tariffs are now taken into account as well.

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32620	7					Although the substantive content here seems fine, this section on 'sectoral policies' needs a pretty fundamental rethink of scope and purpose in particular in relation to Chapter 15. A chapter on "Energy Systems", section on sectoral polciies, is not where I would expect to find discussion of CDM, for example. It may be possible to marry much of the existing content by mapping key instruments on to sectors. For example, carbon pricing is most obviously important - and developed - in in power generation and heavy industry, hence arguably relevance of the text on EU ETS experience etc. This section would seem to be the place to look at the empirical data on Innovation and infrastructure in the energy sector - surely a key empirical observation being that the utility-based industries (and construction) have R&D intensities an order of magnitude lower than in IT or pharmaceuticals etc - we are seeking radical innovation in some of the least innovative sectors on the planet so we need to udnerstand what explains the low level of innovation, why the 'technology valley of death' is so deep in these sectors, and what that implies (discussion of this in a few sources, one review and exposition being in Grubb et al, Planetary Economics, 2013: Chapter 9). Given its title of "policy" this section could also link back to section 7.6 on infrastructure (see my comment on that) to draw out some policy implications. The broader implications in the literature include niche and hybridisation strategies (see for example Raven, 2007). There are also strong implications for regulatory policy and the Impact Assessment frameworks used by government and regulatory agencies (see my comments to Chapter 2, section 2.4).	This section authors has been reframed to meet Vigo Agreement guidelines (Vigo Accord, Section 19.1) which lists in sequence: Economic instruments, Regulatory Approaches, Information programmes, Government provision of public services, Voluntary Actions. As part of this process clear links have be made with Chapter 15 (especially the additional discussion of innovation policy in 15.6). The reference Grubb et al, Planetary Economics, 2013 was added as well as a pointer to 7.6.
20605	7					Cut by 15%.	Rejected - the requested changes concerning the structure agreed in Vigo and the inclusion of many other topics required to extend the space.
23367	7					General: somehwere in this section it could be pointed out more prominently that co-existence of policies (i.e. other policies like support for renewables and energy efficiency, when emissions trading systems are in place) are highly disputed. A key reference would be: a) Böhringer Chr. und K.E. Rosendahl (2010): Green Promotes the Dirtiest: On the Interaction be-tween Black and Green Quotas in Energy Markets", Journal of Regulatory Economics 37(3), 316–325. b) Sijm, Jos, 2005: The interaction between the EU emissions trading scheme and national energy policies. Climate Policy 5 (1), 79-96.	Taken into account - the quoted references are discussed in detail in the IPCC SRREN and in the policy chapters (15.6) of AR5. A pointer to the respective discussion of "adverse interactions" in these chapters has been added to 7.12.
34196	7					The sub-section asks how technology policies can help to complement carbon pricing. It misses important references with a quantitative assessment that is relevant for policy makers in the international context. Bauer et al. (2012) shows that the missing carbon price due to delayed emission pricing policies can be partially compensated by near-term support of renewable energy technologies. The paper shows that the instantenous carbon price in 2020 and the cumulative macroeconomic costs from 2010-2100 of delayed action depend significantly on the level of renewable deployment policies. This means that cost escalation delays in international climate policies to deliver a global carbon pricing regime can be partially offset by technology policies. The paper also points out that future importers of carbon permits (here OECD countries and China) can substantially benefit from such policies because the pioneering renewable policy reduces the value of future carbon emission permits. The paper is attached (bauer_etal_11.pdf) Therein the authors can also find additional references that deal with the same issue. The paper by Rosendahl and Kverndokk is recommended.	Accepted - the paper is taken into account.

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20223	7					Discussion of enabling policies should take into consideration the fact that mulitple liers of policies may actually impede effectiveness and increase compliance and enforcement cost.	Taken into account. Similar to the answer to comment 23367 a revised line in 7.12. emphasis the complementary and potentially conflicting roles of policy mechanisms, and these interactions are then discussed in depth in Section 15.7.
34191	7					Some important issues should be added to the knowledge gaps. First, we do not have consitent assessment frameworks for the assessment of various energy supply potentials. The practice of delimiting fossil fuel availability and the availbility of renewables or nuclear are not consistent with each other. This is required to provide a fair and balanced view across the various energy supply potentials. So far, this is usually left to modellers who are not necessarily equiped with expertise and capability to make these assessments. Too often they take certain assessments as givens and do not question them. This first point is intended as an addition to the issue raised with respect to fossil fuel availability that is already in the text. Second, proper modelling of energy markets is important for the assessment of mitigation costs and emission reduction potentials at various carbon prices. So far the modeling of energy markets (in particular fossil energy markets) is in deep need for improvements. Model comparisons with IAMs revealed that the price levels are very different for coal, oil and gas. Also the price formation mechanisms in the various model approaches were very different. The prices of fossil fuels are very important in order to assess the marginal abatement costs of emission reductions.	Accepted - text revised.
25128	7					The section title could be modified to "Energy extraction, conversion, transmission and distribution"; this is to avoid using the term "energy production" which does not align well with the first law of thermodynamics.	Noted. The two digit section titles are agreed by IPCC Bureau and cannot be modified. In addition, fuel extraction is fuel production in business terminology
20595	7					Cut by 15%.	Accepted. This section was cut approximately by 15%.
32998	7					Chapter 5 (Trends & Drivers) has a dedicated section on energy demand and supply (SOD Section 5.3.3). These sections in Ch 7 could be reduced, referencing Ch 5's discussion wherever possible, thereby reducing overlap and minimizing inconsistencies.	Noted. Text was cut. But it is important to keep in mind that not all readers are going though all WGIII report chapters. The focus of discussions in Chapters 5 and 7 are different. Chapter 7 deals more with sector specific drivers.

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34168	7					The sub-section is supposed to inform the reader about regional evolutions of the energy sectors. However, from the text is to a large degree devoted to the issues of energy security, and here in particular on the perspective of energy importing countries. This is a complete shift of the subject. Surely energy security concerns are important for national policy makers, however, here the reader expects information about regional evolution of the energy sectors, and not a discussion about geo-politics and energy. Also the text has some degree of a regional bias. E.g. there is the phrase "In the last decade, China alone was responsible for over half of the TPES increment" Though this is true the tone sounds too much like an accusation. This will lead to useless discussions with national interests and sentiments. Hence, the CLAs are stongly recommended to revise the entire subsection in order to provide a fair and balanced view on what were the recent evolution of the energy sectors at the regional level that is informative and not provocative.	Rejected. This subsection shows evolution of demand, supply and trade in the global and regional contexts. The energy security issue is touched upon only in one sentence and the comment provider agrees, that this is important. Regarding China: if coal consumption by one country reaches 50% of the global value, it is worthwhile mentioning this fact. There is no accusation either in the tone or in the text. Nevertheless it was removed from the final text.
20596	7					Cut by 15%.	Accepted.
34167	7					The sub-section is supposed to talk about global trends in emission drivers. However, the second sentence turns immediately to the regional perspective. Also, the regions are differentiated into Annex-1 and non-Annex-1 countries. The authors might want to reconsider whether this terminologie is outdated.	Accepted. Text revised.
34178	7					The introduction should emphasis the difficulty to assess the various energy potentials with a fair and balanced view. This is especially relevant as to some degree the use of the various endowments is somehow considereed to be constrained by political, technical, environmental, and economic factors. Emphasis that there is no common methodology to assess energy potentials from fossil, nuclear, renewable (and bioenergy) consistently.	Taken into account. The introductory paragraph has been revised.
20597	7					Cut by 15%.	Accepted. The resources section has been revised and reduced.
34180	7					The section is not mentioning any land-use trade-offs. Also fossil fuel extraction can be a highly land-use intensive activity. Moreover, local environmental problems are not mentioned. The renewables part clearly points out these trade-offs. Hence, the subsection should also mention these issues in order to provide a fair and balanced view on the different energy sources fo rthis assessment.	Rejected: The section focus is resources not costs.
21103	7					The link between fossil fuels and climate change is too short in this section and should me more complete and more explicit. On the opposite, much space is devoted to energy considerations about fossil fuels, which is not the core object of a climate report, so there might be some writing space to regain here.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
21109	7					It would be nice to have a graph in this section representing carbon content of different fossil fuels and carbon emissions allowed by different stabilization scenario, e.g. an update of IPCC, TAR, 2001, SYR, Fig. 7-5 : http://www.ipcc.ch/ipccreports/tar/vol4/english/fig7-5.htm . Even better would be a « peak-oil » like graph presenting fossil-fuel use in the coming years allowed by stabilization scenarios. It could be something like http://www.peakoil.org.au/charts/world.oil.gas.coal.production.1965-2050.gif but taking the climate constrain into account. This should probably be done « all other things being equal » (i.e. no big modification in livestock, no CCS...).	Rejected: This section focus is resources. A link has been made to section 7.11.
34181	7					The sub-esection is not mentioning co-emissions from fossil fuel extraction. There is also the issue of own-energy consumption especially as non-conventional hydrocarbon endowments are considered. Moreover, ther is a debate about land-use change emissions for the recovery of fossil fuels like in the Canadian Oil sands that are below peat-lands.	Rejected: This section focus is fossil fuel resources.

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29968	7					This section focuses almost entirely on electricity. A greater focus on natural gas, oil, bioenergy alternatives (e.g. bio-methane, bio-oil) and the use of alternative energy carriers (e.g. hydrogen) would improve the balance of the section.	Rejected - as section 7.11 has shown that electricity plays an important role in low stabilization scenarios. In addition, important aspects related to (bio) fuels and heat supply options are discussed in the transport, building and industry chapter as well as in the bioenergy Annex of Chapter 11.
29969	7					This section is very detailed and there is scope for referencing other IPCC reports and reducing the length of the section.	Noted. This section does make extensive use and makes many references to the SRCCS and SRREN. Its length has been reduced.
23120	7					Introduce new sub-section "7.5.5. Fusion and other new energy technologies" with text as follows: "A new energy technology generating abundant, zero carbon could theoretically emerge from nuclear fusion or low energy nuclear reaction (see e.g. Storms 2012). While the former benefits from significant public research funding, the latter is developed by a number of small companies; no breakthroughs have been achieved to date. If such a technology could provide low cost power and would fit to the existing power infrastructure, it could generate massive mitigation benefits, but would also require a coordinated introduction in order to prevent economic disruption (Michaelowa and Butzengeiger 2012)." See Michaelowa, A.; Butzengeiger, S. (2012): Climate finance and backstop technologies, in: Michaelowa, A. (ed.): Carbon markets or climate finance?, Routledge, Abingdon, p. 222-254; Storms, E. (2012): An Explanation of Low-energy Nuclear Reactions (Cold Fusion): in: Journal of Condensed Matter Nuclear Science, 9, p. 86-107	Rejected - nuclear fusion is far away from being a solution to the climate problem in the short and medium term.
20598	7					Cut by 15%.	Accepted. The text has been reduced.
33004	7					Section title reads "Mitigation technology options, practices and behavioral aspects", but behavioral aspects receive little to no treatment in the section.	Noted. The scope and emphasis has been changed. Behavioral issues don't play an important role as a mitigation option in the energy supply sector. Behavioral issues, however, are taken into account in the barrier section.
33013	7					In general this section is good, but it tends to stray from what the reader would expect as the key points: 1) what are the technologies/options and how have they developed since the AR4?; 2) How do those technologies/options contribute to emission reductions; and 3) Where and to what extent are these technologies/options currently deployed. In e.g. 7.5.4 (Nuclear) there are already discussions of risks and in 7.5.3 (RE) and 7.5.5 (CCS) there are scenario discussions - all of which seem misplaced.	Accepted - the text now is more focused. Scenario and storage size discussions in the field of CCS now have been moved out of 7.5. In addition, the focus now lies on what progress has been seen since AR4.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24402	7					The section on renewable energy is very brief, and reference is made to the special IPCC report on this. There has also been a special IPCC report on CCS, but CCS is covered much better and in considerably more detail in chapter 7 than renewable energy. Many observers are calling for an eventual transition to 80%, 90% or 100% renewable energy, and RE has the highest growth rates. Many more people will read volume 3 of the AR5 report than will read the special RE report. Also, developing CCS and ramping up nuclear power plant construction will take on the order of decades. RE technology deployment can be increased today. Properly covering all the RE technologies would admittedly require a much longer section, but I would ask the authors to reconsider covering RE in more detail, as it, along with energy efficiency, can provide the most rapid mitigation of climate change.	Rejected, in large measure - The SRREN was very recently published, whereas the SRCCS is more dated, necessitating more new literature in the latter case. In addition, the RE section focuses more on deployment advancements, whereas CCS naturally discusses technical advancements to a greater degree because deployment has been very limited. The text of the CCS section has been substantially reduced to create more parity between these sections, but the different KINDS of information provided remains in large measure because of the different states of deployment (also because the RE section has to address so many different technologies, that very little can be said about any single one). Space limitations simply do not allow us to expand the text on RE in the ways suggested.
34186	7					The sub-section is too long and it contains irrelevant information. The length issue has to be put into perspective with other sections. It comprises nearly three pages. However, it is not assessed as a major and indispensible mitigation otpion (see chapter 6, Fig. 6.23 and 6.15). Also the text reads very much like a standard technical introduction to the status of nuclear power. However, most of the detailed technical information in the first paragraph is largely irrelaevant for the assessment of nuclear being a policy option for the mitigation of CO2 emissions. Also, the paragraph starting on page 28, line 6 begins with the events at Fukushima in 2011 and ends with the number of reactors currently under construction today. The turn in the paragraph is motivated with the notion that several nations have not stoped their engagment in nuclear power investments. The question is what policy makers engaged in international cliamte policy should draw from this? The CLAs are recommended to shorten this sub-section and also to take care that the fair and balanced view is maintained.	Noted - nuclear power is currently the single largest source of low carbon electricity generation, and a legitimate option for future emissions mitigation. The first and proceeding paragraphs provide background on current nuclear technologies that are contributing to GHG emissions avoidance today. The type of reactors has implications for safety, cost and fuel cycle. The discussion of nuclear fuel cycles and reactor technologies is relevant for understanding nuclear's potential as a mitigation option as it affects all aspects of nuclear energy use. The continued construction of nuclear reactors shows that the impact of Fukushima has not affected all current deployment activities.The discussion of Fukushima has been moved to 7.9.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
34187	7					In the last round of reviews I was complaining about literature not being qulaified as peer-reviewed and also some important assessments were missing. In the present draft (the final one that expert reviewers can have a look at) have not found that these remarks were adequately addressed. I ask the CLAs and the Review Editors to take care that thses review comments are adequately addressed.	Noted - Comment on proliferation risk belongs in 7.9 Co-benefits, risks and spillovers. Additional references were added in regards to SMR discussion. Cost of refurbishment and lifetime extensions exists for all power generation options, not solely for nuclear plants.
23363	7					Specific: This section could present findings of recent studies on the effect of a nuclear phase out in response to Fukushima accident (e.g. Bauer et al, Kim et al., Duscha et al.). Findings generally conclude that overall economic effects would be low. For example, . Bauer et al. (2012) analyse the impact of decommissioning existing nuclear power plants and restricting future investments in new nuclear power capacity under long-term emissions caps, which are consistent with the 2°C target. The near-term effect of a nuclear phase-out on GDP is rather small (loss of less than 0.1% in 2020), and somewhat larger in the long-term (loss of 0.2% in 2050). a) Bauer, N., Brecha, R. J. and Luderer, G., 2012, The economics of nuclear power and climate change mitigation policies. Proceedings of the National Academy of Sciences of the United States of America (PNAS) 1201264109. doi: 10.1073. b) Kim S.H., K. Wada, A. Kurosawa, and M. Roberts Nuclear Energy Response in the EMF 27 Study. Climatic Change submitted. c) Duscha, V., Schumacher, K., Schleich, J. , Buisson, P. Costs of meeting international climate targets without nuclear power. Submitted Climate Policy.	Noted - cost of climate mitigation addressed in Chapter 3.
34188	7					The sub-esctin is not dealing with costs, especially investment costs and costs of refurbishment and lifetime extensions. In the last round of reviews I mentioned the latter point and suggested the following reference that was not included by the authors. The Review Editors are recommended to take care of this issue. Schlesinger M, Lindenberger D, Lutz C (2010) Energieszenarien fr ein Energiekonzept der Bundesregierung. Project Number 12/10 (German Federal Ministry of Economics and Technology, Berlin	Rejected - 7.5.4 is only about technological aspects. Cost are not discussed here.
20481	7					shorten	Accepted: Section 7.5.5 has been shortened and significantly reworked to improve clarity and readability.
21105	7					This section is too long and is not sufficiently balanced, as it gives to much space for large expectations on CCS, ignoring the huge uncertainties this technology faces (business case, CO2 storage safety...). The IEA recently revised down dramatically the mitigation contribution of CCS : in the 450 scenario of WEO 2011, CCS was supposed to account for 18 % of GHG reductions up to 2035. In WEO 2012 450 scenario, CCS contribution has shinked to only 12 % of GHG mitigation up to 2035. Also, it should be clearly mentionned that CCS implies more fuel (coal, gas, biomass) for the same result, so some negative impacts (mining, drilling, land use and deforestation) are increased by CCS or BECCS. Mention should also be made of the concerns about increased water use for coal plant equiped with CCS, as reported by Zhai and Rubin in 'Water Use at Pulverized Coal Power Plants with Postcombustion Carbon Capture and Storage' http://www.cmu.edu/epp/iecm/rubin/PDF%20files/2011/Zhai,%20Rubin,%20Versteeg_CCS%20Water%20Use_ES%26T_2011.pdf .Overall, this section could be shortened.	Accepted: Section 7.5.5 has been shortened and significantly reworked to improve clarity and readability.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
27788	7					At the end of this section some aspects connected with CCS should be discussed in more detail: Regional/national storage capacities could be limited due to geological conditions and competing use for natural gas, compressed air energy storage or hydrogen storage. Besides efficiency losses, costs and public acceptance, the most severe obstacle for CCS is the fact that there can not be a guarantee for long-term disposal for hundreds of years. Besides its renewed climate change impact, a major release of CO2 from a storage facility could have impacts on ecosystems (which?) and even cause asphyxiation in the surrounding area. These risks should also be mentioned in the SPM.	Rejected: The technical literature on "a major release" from a geologic repository does not paint such a dire picture as it is not conceivable that a large fraction of the stored CO2 could escape in one large "burp." The bigger concern is a very slow undetected leak that undercuts the environmental effectiveness of CCS or that allows CO2 to escape into something like a basement.
32619	7					This seems to be a section strong on content but with no punchline or conclusion. Surely this is the place in AR5 to give proper exposition to the issues of lock-in, path dependence, and the co-evolution of technology, infrastructure and institutions covered in all the systems development & evolutionary economics literature. Many of the building blocks are there in this section. Link that to the corresponding literatures on these processes and draw out the systemic implications.	Taken into account - lock-in is discussed in 7.10. 5 and the co-evolution of infrastructure and mitigation options is treated in 7.12. 7.6. is reserved to discussing the technological aspects of system integration only.
20599	7					Cut by 15%.	Accepted. The length of the text has been reduced.
20600	7					Cut by 15%.	Rejected - Section text has already, in the past, been reduced significantly. The text that remains fits the page budget allocated.
20601	7					Cut by 15%.	Rejected - more details on cost issues have been asked for by several review comments.
34433	7					This figure should be updated and the underlying data should be made transparent.	Accepted - the figure has been updated and the underlying data now is made transparent. See the methodological annex for the details.
34197	7					The authors are recommended to take the paper by Luderer et al into account, which presents a clear methodology to assess mitigation potentials in the context of an integrated energy system model and not only on a project-by-project baseis. http://dx.doi.org/10.1016/j.eneco.2012.07.022	Taken into account. This recent paper is a useful methodological approach and is cited later in the section via edited text: ie from page43, line 6 "MACS are a useful summary mechanism but improved treatment of interactions between mitigation measures (e.g., Luderer et al. 2012), and more broadly sophisticated modelling of interactions throughout the enrgy systems and wider economy are required."
20602	7					Cut by 15%.	Taken into account - space has been reduced.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25511	7					The report which is published by World Energy Council (2010) Water for Energy could be a reference as a source of the section (ISBN: [978-0-946121-10-6]) :- More in http://www.worldenergy.org/documents/water_energy_1.pdf	Rejected. The reviewer does not say where this reference can be used
29971	7					This section mentions affordability but not energy equity between different population groups as an important socio-economic factor. Energy equity is an important consideration for many governments, particularly where providing energy services is considered a human right (e.g. domestic heat provision in more northerly OECD countries). It would be useful to highlight these issues, particularly as they are not considered at all by most energy system models that are used to identify decarbonisation pathways.	Accepted. This has been reflected in a newly drafted section.
23606	7					I have not been able to find any mention of harmful long term health effects on coal miners, such as silicosis	Rejected. No relevant references were provided to support the review comment.
24406	7					This section does a reasonably good job of listing the various environmental issues with carbon-free energy technologies, but it should also describe how each of these issues have been or are being addressed. For example, the problem with bird kill at wind farms has been greatly alleviated by conducting bird migation studies when locating wind farms and by designing towers that birds cannot perch on. Consequently, the number of birds killed by wind farms is tiny compared to those killed by cats and buildings and is also very small compared to the number that are projected to die due to climate change.	Rejected - Section 7.9.2 addresses bird impacts and mitigation options: "Adjustments in the location, design and operation of facilities can mitigate some of these damages (Arnett et al., 2011; M de Lucas et al., 2012)." Section 9.4 focuses on issues related to public perception, and we do not have the space to discuss mitigation measures in depth, as this would surely require many pages of text. That said, there is a general paragraph in this section on mitigation. Going into more depth on each individual mitigation issue is not possible.
26847	7					While renewable energy has its own public perception issues, these dwindle compared to those of nuclear power. Therefore the order of this section should be changed and public perception issues of nuclear energy should be addressed first, followed by those of renewables. Otherwise the chapter conveys the information that renewable energy has more public perception problems than nuclear energy	Rejected - The first paragraph in the section contains: "Although RE sources often receive relatively wide public support, public concerns do exist." Therefore, the text appropriately highlights the relative positive aspects of RE. Moreover, it is beyond the scope of the section to rank technologies, or to order them by some ranking, as this surely would be very controversial, regional specific, and not reasonably based on broad scientific literature.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26848	7					This section only considers the negative public perception aspects, but fails to incorporate the positive public perception (i.e. support) for different technologies, which is consistently high for some renewables.	Rejected - The first paragraph in the section includes, "Although RE sources often receive relatively wide public support, public concerns do exist", which seems to highlight what the reviewer was concerned about. Discussing this in more detail is outside the scope of the section, and outside of the page limits applied to this section
27048	7					The terms "low carbon" and "zero carbon" energy technologies must be defined. This is absolutely essential to ensure that statements in the text is precise. In Chapter 7 alone, the term is very frequently used, but without any attempt to define it. Most would agree that, when it comes to energy sources, renewables are low carbon and nuclear is low carbon. But where is the cut off? at CCS? gas? It is politician's role in life to conceal populists statements with terminology that is ill defined and therefore sounds nice to everybody. It must be the role of scientists writing the IPCC to provide a coherent and reasonable definition of 'low-carbon' and 'zero-carbon' energy technologies energy technologies to avoid that the text is wide open to interpretation. Please define the terms 'low carbon' and 'zero carbon' if you want to continue using it.	Taken into Account - the term "zero carbon" is removed. "Low-GHG" technologies now are defined to include renewable energy (RE), nuclear power, and carbon dioxide capture and storage technologies (CCS).
40946	7	0				Chapter (7) does not provide a balanced assessment of spillovers related to the development of the energy system, particularly in developing countries.	Accepted - the discussion of spillovers, especially concerning least developing countries has been improved. The Box 7.1"Energy systems of LDCs: Opportunities & challenges for low carbon development" is devoted to this aspect.
21205	7	0				Change term to "modeling" from "modelling" used in the chapter	Noted. Please note that the Assessment Report uses Oxford English. In this regard, "modelling" is used.
20540	7	0				Regrettably I have only had time to read Ch 7 in detail. I find it generally very well informed and clearly written. It complements and updates the IPPC SRREN 2011 well. In reading the chapter I have commented mainly on renewable energy related topics. One general comment on economics: I believe the chapter should emphasise more strongly the well-supported argument that most renewable sources would already be economically competitive with conventional sources if the external costs of the latter were included in their prices.	Accepted - a reference to the discussion of the external costs in the SRREN now is included. No comprehensive update of the external costs has been published since the release of the SRREN.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19764	7	0				There is limited mention to energy storage. This should concern gas and oil storage. Its role is extremely important when it comes to securing smooth supply in periods of excessive demand or supply disruptions. See for example: 1. Corinne Chaton, Anna Creti, Bertrand Villeneuve, 2009 "Storage and security of supply in the medium run" Resource and Energy Economics, Volume 31, Issue 1, Pages 24-38. 2. Jim Skea, Modassar Chaudry, Xinxin Wang, 2012, "The role of gas infrastructure in promoting UK energy security", Energy Policy, Volume 43, Pages 202-213.	Rejected - Chapter 7 is about GHG mitigation in the energy sector. energy security is discussed in as far it is affected by mitigation measures as a co-benefit. A general discussion of energy security is outside the scope of the report. The importance of energy storage for intermittent renewables, however, now is discussed in more detail in Sec. 7.6.
19765	7	0				There is only limited reference to electricity storage. Given this is the missing part of the electricity supply chain and one that could enable huge deployment of interrmitent renewables it cannot be seen as a minor issue. See for example: 1. Kanakasabapathy P, 2013, "Economic impact of pumped storage power plant on social welfare of electricity market", International Journal of Electrical Power & Energy Systems, Volume 45, Issue 1, Pages 187-193. 2. Dimitrios Zafirakis, Konstantinos J. Chalvatzis, Giovanni Baiocchi, George Daskalakis, 2013, "Modeling of financial incentives for investments in energy storage systems that promote the large-scale integration of wind energy", Applied Energy, Volume 105, Pages 138-154.	Accepted - the discussion of energy storage is extended. The references are cited.
19767	7	0				There is no section that deals with energy supply security per se but the whole concept of energy supply diversity and its contribution seems to be ignored. Useful references are below: 1. Andrew Stirling, 1994, "Diversity and ignorance in electricity supply investment: Addressing the solution rather than the problem", Energy Policy, Volume 22, Issue 3, Pages 195-216. 2. Michael Grubb, Lucy Butler, Paul Twomey, 2006, "Diversity and security in UK electricity generation: The influence of low-carbon objectives", Energy Policy, Volume 34, Issue 18, Pages 4050-4062. 3. Shimon Awerbuch, Spencer Yang, 2008, "Chapter 5 - Efficient Electricity Generating Portfolios for Europe: Maximizing Energy Security and Climate Change Mitigation", Analytical Methods for Energy Diversity & Security, Pages 85,87-115.	Taken into account - an extended discussion of energy security issues now is part of section 7.9.1 "Socio-economic effects". Co-benefits of mitigation options with respect to energy security now are part of Table 7.3.
19766	7	0				As it is already aknowledged in Chapter 7 one of the main issues of energy security is that of import dependence. This table could include reference to this paper: Hai-Ying Zhang, Qiang Ji, Ying Fan, 2013, "An Evaluation Framework for Oil Import Security Based on the Supply Chain with a Case Study Focused on China", Energy Economics, Available online 29 March 2013 2. Konstantinos J. Chalvatzis, Elizabeth Hooper, 2009, "Energy security vs. climate change: Theoretical framework development and experience in selected EU electricity markets", Renewable and Sustainable Energy Reviews, Volume 13, Issue 9, Pages 2703-2709.	Accepted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26922	7	0				The optimism associated with particular technologies in this chapter is not in line with reality. Natural gas is discussed with great optimism, yet is not a viable technology for achieving stringent stabilization targets, e.g. 450 ppm CO2e (see: Levi, Michael. "Climate changes of natural gas as a bridge fuel." Climatic Change. January 2013.). CCS is also featured prominently in the chapter and discussed as a key option for mitigating CO2 emissions, yet is not commercially viable and has barely been tested at the commercial scale. Finally, renewables, which have been deployed at the commercial scale and have immense potential for growth, are discussed last in a less optimistic manner. To be sure, there are significant challenges facing renewables, but there is also a wealth of literature addressing these challenges and how they can be confronted.	Taken into account - the role of gas as a transitional option now is emphasized. CCS is presented in a more balanced way. The space devoted to CCS, however, has not been reduced considerably as it plays a prominent role in the long-term scenarios. This implies that the benefits and shortcomings of this technology must be discussed in detail. The important role of RE is emphasized. As RE have been discussed in detail in the IPCC SRREN, less details are presented in the AR5. The challenges associated with RE and options to address them are discussed in 7.6.1.
30909	7	0				References are made throughout this chapter to the Cancun Agreements and against which to assess viability of mitigation options in the energy sector. Is this specific reference to the Cancun agreements upheld consistently in other chapters and the SPM? Consideration may be needed for how these comparative references are made, particularly if this comparison is not made consistently throughout the WGIII contribution.	Noted - the Cancun Agreement plays a prominent role in international negotiations. The target therefore has been investigated in detail in Chapter 7. Chapter 7 is in line with other chapters with respect to that treatment.
30910	7	0				Energy sector and energy supply sector are used interchangeably throughout this chapter. Clarity on whether there is a difference in these terms, or if in fact they can be used interchangeably should be noted.	Accepted - the difference now is highlighted
25130	7	0				The chapter is very intensive and informative; reducing any part will have to compromise with losing some information. A few suggestions could be as follows: (1) There is not much discussion on Table 7.1; it could possibly be removed or put into an appendix; (2) The Figure 7.6 could be removed if the information there could somehow be integrated into Table 7.2; (3) The information in Section 7.10.4 (Human capital capacity building) could somehow be integrated into the section on co-benefits (Section 7.9.1) as there is some overlap in terms of employment even though it is appreciated that the two sections address different issues; (4) The Section 7.11.3 can possibly be considered for removal or shortened since the main point is somehow included in other sections in the chapter.	Taken into account - although Table 7.1 stays in order to support readers that are interested in the most recent snapshot of the global energy balance, figure 7.6 is removed. The division of labor between 7.9.1 and 7.10.4 has been improved. 7.11.3, in contrast, plays an important role for Chapter 7. Albeit overlaps with chapter 6 were reduced, the topic has to be discussed in chapter 7.
32618	7	0				There is probably no scope to amend but ideally the chapter should be titled "Energy production and supply systems" to make it plain that it doesnt encompass energy demand	Rejected - titles cannot be changed anymore.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24619	7	0				The introduction to this chapter could adopt something like the Buildings chapter approach, where the chain of factors influencing energy requirements in each sector are distilled out, and their potential to drive very strong mitigation if appropriate technology innovation (as per AR4 WG III analysis) and policies are applied.	Rejected - the introduction does not serve as a second executive summary. The importance of demand side measures, however, now is emphasized. The Kaya Identity is not used in Chapter 7, as the mitigation options in this sector are "supply side" options per definition. The interaction with demand side options now is highlighted.
24620	7	0				Suggested reference: Alan K. Pears, Imagining Australia's energy services futures, Futures, Volume 39, Issues 2–3, March–April 2007, Pages 253-271, ISSN 0016-3287, 10.1016/j.futures.2006.01.012. (http://www.sciencedirect.com/science/article/pii/S0016328706000103). This paper reframes energy in a context of energy as one input to provision of 'useful services'. It may provide a useful perspective for this chapter.	Rejected - the chapter focuses on energy supply. Energy services are discussed in the end-use sector chapters.
24621	7	0				Suggested reference: the Australian 'energy efficiency exchange' website. Citation - Australian Government Department of Resources, Energy and Tourism (2013). Energy Efficiency Exchange website. URL: www.eex.gov.au The Energy Efficiency Exchange is a joint initiative of the Australian, state and territory governments administered by the Department of Resources, Energy and Tourism. It aims to support the development and implementation of energy management and energy efficiency strategies by providing quality information from respected national and international sources in one location. It includes a range of recently researched and thoroughly referenced material looking at significant energy efficiency potential. In many areas, it seems to go beyond existing resources in this chapter in identifying innovative mitigation/energy efficiency strategies.	Rejected - the chapter focuses on energy supply. Energy services are discussed in the end-use sector chapters. The IPCC is to consider the current state of science, where possible as evidenced by peer reviewed journal publications. We cannot reference general websites, especially if the purpose of the reference is not clear.
24622	7	0				Since the data and modelling results are aggregated for regions, it is not possible to verify the Australian data used, or the sources of this data. It will help if individual country data is provided in Appendices.	Rejected - some comments above request elimination of country-level details whatsoever. The size and the scope of the chapter, as well as the whole WG III report, do not allow for providing data and modeling results for all countries. Moreover, as a rule, models use regions, rather than countries, so their outputs provide no country-level details at all.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24623	7	0				While it is covered in part, particularly in the context of transmission and distribution, we feel that energy efficiency's role in GHG and demand reduction in general could do with greater coverage in this chapter, in line with the amount of content given to other areas e.g. gas generation and RE.	Taken into account - the chapter focuses on energy supply. Energy services are discussed in the end-use sector chapters. Nevertheless, the importance of demand side measures is highlighted in 7.11 as it provides the "scale of the energy system" which has important consequences for energy supply. In addition, energy efficiency measures in energy conversion and delivery now are addressed in more detail throughout the chapter.
24624	7	0				A number of technical terms in this chapter are not explained, while others are defined within the text itself but not at the point at which the term is used for the first time. Presumably, these will be addressed in a glossary of some kind, but there is no indication of which terms will be in the glossary and which will be defined. Examples of technical terms "levelised cost," "carbon endowment" "Kaya identity" Suggest that it would be useful in further drafts to clearly format the terms that will be in the glossary, and/or give full definitions of technical terms within the text.	Taken into account - technical terms are explained either in the text itself or in the glossary.
24625	7	0				Inconsistent use of "Fukushima accident" and "accident at the fukushima dai-ichi plant" throughout chapter	Accepted - a consistent name now is used.
21084	7	0				In general, I believe the draft is well balanced, comprehensive and informed. All the comments I made on the FOD have been taken on board in one way or another. While I do not fully accept everything in the latest draft I find all the statements in it defensible and adequately supported. I therefore have only the few minor comments below.	Noted - no further action required.
21766	7	0				The chapter covers a wide range of mitigation options and issues, combining technical and empirical detail with a review of current trends and future opportunities. Overall, however, the coverage is very imbalanced with a strongly dominant emphasis on the electricity system and particularly electricity general, and an associated lack of coverage/discussion of (1) other energy carriers (particularly liquid fuels and also heat); (2) almost all upstream activities (including exploration, mining, drilling, transport); (3) infrastructure issues (transmission, distribution, import/expert). In particular, the chapter fails completely to address trends and opportunities with "smart" grids (dismissing the concept as ill-defined), and dedicates almost no attention to distributed generation and the potential changes this may have on the electricity and heat sectors. These biases in coverages are striking.	Taken into account - based on the division of labor agreed with the chairs of WG III, chapter 7 treats the energy supply systems with a special emphasis on power generation and delivery. Liquid fuels are considered by chapter 8 (transport), while heat is treated by 9 (buildings) and 10 (industry). The discussion of upstream issues as well of infrastructure issues has been improved considerably. Distributed generation, energy storage, virtual power plants and the smart grid are now discussed explicitly.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21767	7	0				Of the four broad mitigation options involving fuel substitution (fuel switching within fossil fuels, nuclear, RES and CCS), CCS is given a disproportionate amount of weight and at times the chapter reads as a CCS apologia with frequent citing of its promoting industry body. (Heavy and at times exclusive reliance on the Global CCS Institute for CCS, and to a lesser extent, REN21 for RE, is inappropriate as these are industry advocacy bodies)	Taken into account - the chapter has been revised to remove references to GCCSI as a citation for substantive technical points. Beyond RE, CCS (especially in the form of bioenergy CCS) plays an important role in low stabilization scenarios. Concerning page numbers RE (which have been discussed in detail in the IPCC SRREN report recently) now cover 2 pages, nuclear 2.5 and CCS 2 pages (see 7.5.3 - 7.5.5). Any additional imbalance is avoided.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21768	7	0				The chapter is on "energy systems" but should be on the "energy sector". It seems self-evidently absurd to exclude the use of energy from a chapter on "energy systems" but the energy sector can more legitimately be defined as the upstream and secondary conversion sectors of the energy system (i.e. excluding the final energy and energy end use). One section (7.11) does however explicitly draw out the crucial relationship between changes in energy demand (relating to mitigation) and the implications these have for decarbonisation in the energy sector. The chapter needs to steer a clearer and more explicit line in its coverage of the energy sector versus the energy system (i.e. the energy sector together wtih energy demand or end use). The best option would be to remove the integrative section (7.11) completely and move it to chapter 6. It would also be helpful to have a clear "roadmap" to the chapter set out upfront (perhaps building on Fig. 7.1, or better still, using global Sankey diagrams of energy flows from primary to secondary through infrastructure to final energy and energy services). The sections that follow could then be linked explicitly to the elements or connectionsin the energy sector being covered.	Taken into account - the division of labor agreed with the other chapters is the following: End-use issues including demand reduction and other demand side measures are treated in chapter 8 - 11. Chapter 7 discusses mitigation options in the energy SUPPLY sector. This relates to the specific technologies, their co-benefits and risks, their costs and their mitigation potential. The discussion of least cost scenarios in chapter 7.11, however, has to consider the "scale" of the energy system, which is defined by the respective energy demands. The transformation pathway discussion therefore takes trade-offs between demand side options and supply side options into account. The division of labor discussed here now is clarified in the introduction, where the importance of taking into account the interaction between demand and supply is highlighted. The terms "energy systems", "energy sector", etc. now are clearly defined and used consistently. 7.11 is an integral part of chapter 7 as it describes the implications of the requested energy demand for mitigation needs in the supply sector. 7.11 therefore cannot be removed. The concepts that are used and the alignment with other chapters, however, have been clarified.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21769	7	0				It is not clear whether the purpose of the chapter is to provide an update of improved knowledge and understanding since the 2007 AR4 and the 2011 SSREN, or whether it is to provide a broad synthesis of all relevant mitigation issues. At present, the chapter seems to sway between the two poles, providing a lot of detail which is not novel in order to ensure broad coverage, but in other areas more narrowly emphasising recent trends and novel findings. The chapter needs to set out more clearly what its objective is. This includes a clearer statement of how the chapter differs from what is already readily available from the International Energy Agency and particularly from the 2012 Global Energy Assessment.	Accepted- the chapter now clearly presents recent findings and novel trends compared to the IPCC AR4 and the IPCC SRREN. Basic concepts and the broad discussion of fossil fuel resources have been deleted. Especially due to the updated transformation pathway section 7.11, the value added compared to the GEA, 2012 assessment now becomes visible. The scope of the chapter now is clarified in the introduction.
21892	7	0				While a number of technologies and issues are discussed there is only limited reference to electricity storage. Given this is the missing part of the electricity supply chain and one that could enable huge deployment of interrmitent renewables it cannot be seen as a minor issue.	Accepted - energy storages now are discussed as requested.
20304	7	0				The chapter is strongly focused on the supply of electricity and to a minor part on heat. The term "energy system" as used throughout the chapter thus is limited to the "supply of eectricity and heat". A broader understanding of energy systems includes the supply of energy for transport (as of cours dealt with in a separate chapter) or emphasises the cascadic structure of the energy system starting from energy services and illustrating the effects of changes in the demand side sectors for the supply side sector of electricity and heat. A clear statemeent at the beginning of the chapter making clear that "energy system" is understood as supply of electricity (and heat) would thus be valuable.	Taken into account - based on the division of labor agreed with the chairs of WG III, chapter 7 treats the energy supply systems with a special emphasis on power generation and delivery. Liquid fuels are considered by chapter 8 (transport), while heat is treated by 9 (buildings) and 10 (industry). The discussion of upstream issues as well of infrastructure issues has been improved considerably. A new design of Figure 7.1 now emphasizes the cascadic structure of the energy supply system. The fact that chapter 7 concentrates on power is highlighted in the introduction.
20594	7	0				Chapter 7 elaborates too much in CCS relative to other mitigation options, e.g. renewable energies. How about bio-char/terra preta?	Noted - The scope of Chapter 7 was defined so as to focus on the energy system. Biochar/terra preta is something that should be covered in the landuse chapter. Biochar is not an energy technology therefore it is out of scope for Chapter 7.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32990	7	0				In nearly every section that nuclear energy is mentioned there is an accompanying mention of the Fugushima incident. While it is important to mention this event, it should be done in context, e.g. in Section 7.9 and not consistently highlighted throughout the chapter (e.g. in the ES p. 5 line 33, and Section 7.5 p. 28)	Rejected - the accident itself is not described several times. What is discussed are the resulting consequences which must be treated in different sections according to the chapter outline. The accident itself is discussed in 7.9. as requested.
33014	7	0				Five mitigation options are presented at the beginning of the chapter, but only three of those options are systematically discussed throughout the chapter. Discussions often omit 1) energy efficiency improvements in fuel extraction and conversion, and the mitigation of fugitive emissions; 2) energy efficiency improvements in transmission and distribution. If these options are not systematically discussed, it would be useful to clarify where and why they are omitted.	Taken into account - Discussion on these issues has been extended
33066	7	0				Throughout the chapter there are occassional mentions to individual countries. Where you have singled-out countries, please assure that there are strong reasons for doing so. If this is not the case, it may be preferable to instead refer to the regional groupings as defined in Annex II.	Rejected - Literature provides much information on a country level. For example, nuclear accidents are very country-specific. It makes no sense to discuss regions in relation to such topic or shale gas, which is currently mainly produced in the US. So, in many cases some developments need to be discussed on the country level, and therefore some mentioning of individual countries is unavoidable. This however, is constrained to those cases where the behavior of important countries deviates from that of the region they belong to.
30061	7	0				chapter 7.5.4 at least in relation to 7.5.3 much to detailed and to long. Not more than 30 to 40 lines required	Rejected - nuclear is a valid mitigation option that has not been treated in a special IPCC report so far. Compared to RE and CCS, for which these reports are available, the page number is justified.
30062	7	0				chapter 7.5.5 at least in relation to 7.5.3 much to detailed and to long. Not more than 20 to 30 lines required	Rejected - CCS plays a prominent role in the transformation pathways as presented in 7.11 and chapter 6. It is therefore necessary to discussion the benefits and shortcomings of this technology in detail. The page number corresponding to RE is small as RE have been discussed in a special IPCC report in detail recently.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36683	7	0				Although titled "Energy Systems", the Chapter focuses heavily on energy supply systems. Authors should, throughout the text, better clarify linkages to energy demand, and explicitly cross-reference other relevant chapters.	Accepted - the distinction between "energy system" and "energy supply" now is emphasized. In addition, the cross-referencing is improved.
36684	7	0				The Executive Summary includes several findings that appear to editorialize or otherwise stray from what is supported by the sections of the chapter they purport to summarize. Recommend that the authors revisit the ES to confirm that the findings are adequately supported in the referenced chapter sections.	Accepted - the ES has been considerably improved along the suggested line.
36685	7	0				The style of citing references is inconsistent throughout the chapter; sometimes first initials (and sometimes spelled-out first names) are used with last names, but the convention is to only use last names. It is particularly pronounced in section 7.5.5.	Accepted - text revised.
36686	7	0				There is an inconsistent and inadequate treatment of biomass for fuels, i.e., biofuels - distinct from biomass used directly for electricity or heating: Biofuels are included in some sections but conspicuously absent from others - with arbitrary variability across sections 7.2, 7.4, 7.5, 7.6, 7.8, etc. Suggest expanded coverage of biofuels in the chapter, as a whole. While Ch. 11 presumably provides details, Ch. 7 should at least note/summarize biofuel issues, wherever relevant.	Taken into account - Comments addressed; biofuels mentioned in the introduction, then summarized in the renewable energy technologies (7.5.3) and a figure of the volumes of biofuels in recent years was added. It is discussed in 7.6.3 Fuel Supply System and in the 7.9.1 Socio-economic impacts providing an example of small scale ethanol cooking stoves in a LDC. In addition, the two current ethanol production plants that are providing CO2 for enhanced oil recovery are cited as precursors of broadly applied BECCS. The transportation chapter continues to address biofuels as appropriate; the industry chapter addresses pulp and paper industry; buildings addresses heating and related aspects; and the AFOLU Annex treats all of these in a more integrated way from a mitigation perspective.
36687	7	0				As a general matter, the issue of electricity system integration of renewables is inadequately treated. This is a major challenge for renewables and there are options but this chapter does not deal with them adequately.	Accepted - chapter 7.6.1 has been improved considerably. Integration options (energy storages, virtual power plants, smart grids, etc.) are now discussed in more detail as well as the challenges associated with integrating RE.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36688	7	0				Disproportionate focus on technical potential may mischaracterize (over-estimate) practical viability/real-world operability of featured mitigation options. There is some balancing treatment of costs, but limited to engineering costs. Please broaden/balance approach to evaluating options, to capture a fuller ensemble of determinants, including the opportunity costs of alternative public policy choices.	Rejected - Section 7.4.2 very clearly identifies the limits to technical potential estimates, and later sections of the chapter (7.6.1, 7.11) address many of these limitations (e.g., integration and integration costs, local environmental concerns, etc.), and even more text on these limitations has now been added in 7.4.2. IAM modeling results capture a SUBSET of these practical limits, and are also discussed. It is not evident here what exact additional text is desired. We are also not certain what it means to broaden the discussion to include "opportunity costs" - would need clarification on what is meant here to address this point.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36689	7	0				Assumptions of renewable energy mitigation potential are not supported by recent studies Earlier RE analyses, including IPCC (2007) and IPCC (2011a), assume that RE will offset fossil fuel use and therefore mitigate GHG. However, there is no a priori basis to assume that RE mitigates GHG in situ. Recent empirical analyses suggest that modern solar and wind power have not offset fossil fuel use in practice and that other RE technologies may only partially offset fossil fuel use (York, 2012). Analysis of historical and behavioral characteristics of energy use suggest that RE may have greatly limited ability to offset fossil fuel use, or may even accelerate fossil fuel use, if deployed within a context of growing economies and populations (Zehner, 2012). York, R. (2012). Do alternative energy sources displace fossil fuels?. Nature Climate Change 2, 441–443. (DOI:10.1038/nclimate1451) Zehner, O. (2012). Green illusions. University of Nebraska Press, Lincoln and London.	Accepted, in part - Some text has been added to accommodate this point in the policy sections. In general, the future mitigation potential of RE is very well supported by recent studies, including those by the IPCC that have reviewed the scientific literature (mitigation potential does not mean that carbon emissions will go down in absolute value, but simply that RE will reduce carbon emissions below what they OTHERWISE would have been). It goes without saying that a renewable MWh must offset another MWh, and that MWh will almost always come from fossil energy. Issues related to the rebound effect and spillovers, however, are important, and may reduce (or conceivably even eliminate) the mitigation results of RE or other low-carbon options, depending on the specific measures used to support those low-carbon options. Rebound effects and spillovers are addressed in other chapters of the AR5, focusing admittedly on energy efficiency as that is where the literature is most developed, but we have added some text in the policy section to acknowledge these possible effects. Literature on the rebound effect / spillovers on RE (or CCS, nuclear, etc) is extremely limited, and is not in our view well-enough developed for detailed exploration in Chapter 7. Indeed, to the extent that low-carbon supply options are more expensive than other energy sources, then increased deployment of those options may induce higher energy prices, and therefore more energy
36690	7	0				The first 1/3 of this chapter (sections 7.2 and 7.3) seems entirely dedicated to reporting energy statistics in "narrative form." Not only is this form of exposition inefficient, it is done inconsistently between different sub-sectors of the "Energy Systems" sector. While the differences between total consumption, percentage consumption, consumption growth rate and global share of growth are important, they would best be handled in a few well-explained graphics (pie charts, bar charts, etc.). Instead, the authors seem to be filling pages (which need to be cut) with a verbal re-hashing of what could more readily be found by looking at the last few years of IEA data. Sections 7.2 and 7.3 could be condenses with no loss of value.	Accepted - text revised and shortened considerably.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36691	7	0				Chapter tends to simplistically consider the energy system in isolation, neglecting broader/integrated energy-Eart system context. It would be appropriate to at least note land-energy linkage via bioenergy, and reference intersection with Chapter 6 (Section 6.3.5), especially since the AR5 scenarios database specifically showcases IAMs (notably GCAM) strong in capturing land-energy dynamics.	Rejected - these issues are better addressed in other chapters of the AR5, and those links already exist in substantial measure in the introduction and in other sections of the chapter. The cross-referencing, however, has been improved.
36692	7	0				The use of 1990-2000 and 2001-2010 is consistent throughout the document (starting on p. 4, line 7), but these represent 11 years and 10 years respectively. It would be better to have both periods be 10 years, e.g., 1991-2000 and 2001-2010, for purposes of comparing changes over a decade.	Accepted- Text edited accordingly.
36693	7	0				Need to consistently identify annual percentages as such, i.e., "X% per year." For example, on p. 4, line 8: Add "per year" after "3.6%", i.e., "3.6% per year" - to ensure "per year" applies to both time periods being discussed. Same applies to numbers on p. 12, line 11, and in other sections.	Accepted - Text edited accordingly.
36694	7	0				Broad issue with this chapter: "medium agreement, medium evidence" is severely overused. Suggest the authors reconsider this "middle ground" approach. For example, "There is a growing body of literature on how to ensure the integrity of CO2 wells, on associated leakage rates, on the potential consequences of a pressure build up within a formation caused by CO2 storage" is a statement that is true with 100% confidence, unless no papers have been published in any of these areas in recent years; nonetheless, it is marked as "medium agreement, medium evidence." This is an extreme case, but there are others like it. Relatedly, the chapter authors could be more decisive in assessing competing papers. For example, Howarth et al's work on methane leakage has been refuted repeatedly, yet it is still cited in a "he said, she said" fashion, in the chapter. It may be that high levels of methane leakage are occurring, but even if they are, it has been shown pretty solidly that Howarth et al did not successfully establish that claim. The authors need to acknowledge papers that have been repeatedly shown to be wrong, but still persist in the literature - otherwise, it is not clear what it takes for a paper to not be cited.	Accepted- the ES has been revised considerably in order to reflect the outcome of the underlying text in a more appropriate way. In addition, the uncertainty statements have been reviewed carefully and adjusted where appropriate. The paper of Howarth has been put into perspective by adding other ones which provide a critique.
36695	7	0				The chapter would benefit by the addition of information on demand side energy reductions (i.e., energy efficiency) and behavioral approaches to reductions.	Rejected - although this would be good, the outline of the report suggests that demand side issues are discussed in the end-use sector chapters (building, transport, industry, ….). The transformation pathway section 7.11 however shows the trade-offs between demand and supply side options.
36696	7	0				Agreement/evidence levels often inconsistent with the statements to which they are assigned: "Medium" confidence, in particular, repeatedly under-represents the robustness of facts or incontrovertible evidence. Request that authors work with TSU, to ensure accurate application of confidence intervals.	Accepted- the ES has been revised considerably in order to reflect the outcome of the underlying text in a more appropriate way. In addition, the uncertainty statements have been reviewed carefully and adjusted where appropriate.
25890	7	0				The chapter underplays the system and integration issues related to both electricity and heat. There are only a couple of sentences on electricity storage and heat storage appears not to be mentioned at all. Both the recent Global Energy Assessment (Chapter 15) and the IEA nergy Technology Perspectives 2012 (Chapters 5 and 6) contain material that could be usefully referenced.	Taken into account - power storages and heat storages now are discussed in more detail.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
27756	7	0				This chapter features a very good multi-dimensional analysis of the different mitigation options, pointing out all the benefits and drawbacks of the specific technologies. Unfortunately, it fails to make any recommendations as to which mitigation options are preferable. This is especially surprising since the concept of sustainable development, which could have acted as an evaluation scale, is featured so prominently in the report. It seems to me that the idea of being "policy relevant but not policy prescriptive" was misunderstood as meaning that no value judgements should be made at all (in other parts, these judgement calls are made, see for example chapter 7, page 56 "The biggest barrier, however, is the lack of a coherent global climate policy that is committed to the deep emission reductions needed to obey the Cancun Agreement"). In the end, this leads to a text that leaves policy makers without any clear guidance, the report becoming thus less policy relevant. This is especially apparent in the FAQ 7.2. In conclusion, I strongly suggest a subchapter comparing different mitigation options with regards to their sustainability.	Taken into account - the co-benefits and adverse side effects as well as the risks associated with RE and especially with nuclear and CCS are now discussed in more detail. The "up-scaling" challenge associated with the transformation pathways in terms of single options such as CCS and nuclear now is presented as a "reality check" in various subsections of 7.11. As there is no single criteria that could serve as a generally accepted selection criteria, the weighting of the various goals discussed in 7.9 and the final selection of "appropriate" mitigation options must be left to the policy-makers. However, the updated version of 7.11 now facilitates to carry our this demanding task.
27757	7	0				Whole Chapter 7, especially chapter 7.5: The chapter is dealing with reducing specific GHG emissions per kWh produced or delivered. One more basic aspect is missing: Reducing the demand for electricity (or, for heating and cooling networks, heat or cold) as a means to reduce GHG. This can be achieved both by energy saving and by efficient appliances/buildings etc.. This important link is missing and should be added. If it is already included, it should be stressed more explicitly.	Taken into account - although this would be good, the outline of the report suggests that demand side issues are discussed in the end-use sector chapters (building, transport, industry, ….). However, although the discussion of demand side measures is left to chapter 8-11 from a technology point of view, trade-offs between demand and supply side options are taken into account in discussing the results of the transformation pathways which capture the interaction between demand and supply. The respective link is emphasized in 7.1 and 7.11.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25150	7	0				**Implicit assumption of renewable energy mitigation potential are not supported by recent empirical, behavioral, and macroeconomic analyses The authors have an opportunity to confront an apparently unwarranted assumption throughout the SOD that additional renewable energy (RE) production will necessarily offset fossil fuel use. The SOD refers to this process as mitigation. Earlier RE analyses, including IPCC (2007) and IPCC (2011a), also assume that RE will offset fossil fuel use and therefore mitigate GHG. This assumption is highly problematic for several reasons. First, there is no a priori basis to assume that RE mitigates GHG in practice. Related, IEA (2013) finds that while $2 Trillion was spent globally on green energy between 1990 and 2012, GHG emissions did not decrease, but jumped 44%. According to the report, "The picture is as clear as it is disturbing: the carbon intensity of the global energy supply has barely changed in 20 years, despite successful efforts in deploying renewable energy." Secondly, recent empirical analyses suggest that modern solar and wind power have not offset fossil fuel use in practice and that other RE technologies may only partially offset fossil fuel use (York, 2012). Third, analysis of historical and behavioral characteristics of energy use suggest that RE may have greatly limited ability to offset fossil fuel use, or may even accelerate fossil fuel use, if deployed within a context of growing economies and populations (Zehner, 2012). Finally including this often implicit mitigation assumption could be critiqued as obscuring or avoiding questions regarding the scale of energy use. That is, placing RE on a pedestal as a solution or partial solution for GHG emissions may overshadow discussions about consumption, population growth, and increasing demand for energy through economic growth. The review recommends that the authors remove the apparently unwarranted assumptions that RE offsets fossil fuel use and that RE mitigates GHG emissions. These assumptions appear in, but are not limited to, the following sections of Chapter 7: pg.4 lines 23, 40-41 pg.5 lines 22-24 pg. 19 lines 18-19 pg. 33 lines 33-34 Section 7.8.1 Figure 7.17 pg. 61 lines 28-33 pg. 69 lines 12-19 IEA. (2013). Tracking clean energy progress 2013 IEA Input to the Clean Energy Ministeria	Accepted, in part - Some text has been added to accommodate this point in the policy sections. In general, the future mitigation potential of RE is very well supported by recent studies, including those by the IPCC that have reviewed the scientific literature (mitigation potential does not mean that carbon emissions will go down in absolute value, but simply that RE will reduce carbon emissions below what they OTHERWISE would have been). It goes without saying that a renewable MWh must offset another MWh, and that MWh will almost always come from fossil energy. Issues related to the rebound effect and spillovers, however, are important, and may reduce (or conceivably even eliminate) the mitigation results of RE or other low-carbon options, depending on the specific measures used to support those low-carbon options. Rebound effects and spillovers are addressed in other chapters of the AR5, focusing admittedly on energy efficiency as that is where the literature is most developed, but we have added some text in the policy section to acknowledge these possible effects. Literature on the rebound effect / spillovers on RE (or CCS, nuclear, etc) is extremely limited, and is not in our view well-enough developed for detailed exploration in Chapter 7. Indeed, to the extent that low-carbon supply options are more expensive than other energy sources, then increased deployment of those options may induce higher energy prices, and therefore more energy

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25152	7	0				**PV cost data inadequate to support claims and inappropriate for policymaking (includes internal conflict and affects Technical Summary p32 and Summary for Policymakers pg 17) Chapter 7 provides multiple claims regarding decreasing photovoltaic (PV) costs but does not appear to contain relevant data to support this claim. First, the Second Order Draft PV datasets do not account for the effects of subsidies. Second, the datasets do not reflect installed costs. Retail PV module prices may be of some small interest to readers but these nominal costs represent only a fraction of an installed solar system cost. In its curren form, the PV cost data neither conform to generally accepted cost accounting practices for policymaking nor supply an adequate basis for comparison with conventional baseload power supply. It should be noted that the current presentation of data leads to unsubstantiated claims in the Summary for Policymakers, Technical Summary, and Executive Summary as well as apparent internal contradictions within Chapter 7. The reviewer offers suggestions at the end of the comment. Apparent internal contradictions exists between Figure 7.11 and 7.10.2. Figure 7.11 shows a PV cost drop between 2007 and 2011 yet subsidies and feed-in tariffs for solar power rose significantly over this period according to data in 7.10.2. To review, Figure 7.11 (also TS.20) shows PV costs declining between 2007 and 2011. Numerous sections of the report (including 7.5.3 and 7.8.2) reference PV cost declines and characterize PV as achieving grid parity in some regions. Figure 7.11 (TS.20) reports a PV capacity cost of $1.2 USD/W for 2011. First, section 7.10.2 contains data on PV “investments” of $143 billion in 2012 and roughly $159 billion(est.) in 2011 (7.10.2). Dividing the 2011 investment in 7.10.2 by the change in capacity on Figure 7.11 (about 6800MW) yields $23/W. It will appear to discerning readers that said $1.20/W of capacity required $23/W of investment in 2011. To what extent is the perceived price drop in Figure 7.11 simply a reflection of increasing subsidies? Second, Figure 7.11 cites Navigant Consulting for PV cost data. In the referenced report, Navigant claims that PV labor costs for an installed system are $6/W. How do installed costs of solar compare over time? These observations bring into question the selection of the $1.20 figure. They also bring into question the value of allowing nominal retail prices of PV to speak for the cost of PV systems in situ. The reviewer recommends the following opportunities to clarify the draft while addressing full PV costs rather than retail panel costs. If reconfigured, this section on PV cost data would be incredibly helpful for policymakers and researchers alike. First, the authors may assemble investment, subsidy, and feed-in tariff data by year in order to assess a change in cost of PV modules adequate for comparison and policymaking. Second, the reviewer recommends that the authors use installed-cost data such as that from the California Energy Commission or a comparable large experience-based dataset as a basis for historical PV cost analysis.	Accepted, in part - Ultimately, installed prices and module prices are inputs to LCOE - LCOE as well as other infrastructure costs are the final metrics of importance. This means that module prices and installed prices (and price reductions) are important, but reductions in those values must be considered within the context of the impact on LCOE. Overall, module prices, installed prices, and the LCOE of PV have all declined substantially in recent years, and this development is important relative to the position of PV during the AR4 timeframe. The module prices and LCOEs reported in the text, while they may have been affected by past policy efforts, do not substantially include the effect of any specific country policies, so should be ok as a basis for comparison. Market-based module prices, for example, align reasonably well with the production cost of PV modules that can be discerned from PV manufacturer investment reports (because supply > demand at present, in fact, the market prices are below production costs for some companies, but are in line with production costs for others). Notwithstanding these points, to accommodate this good comment we have: (1) deleted Figure 7.11; (2) revised or eliminated the text previously on page 40, line 11, in the ES, and in section 7.5, focusing now on LCOE as the important metric.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25153	7	0				**Accepting biomass as a renewable energy creates an internal contradiction The authors have an opportunity to greatly strengthen the Second Order Draft (SOD) by resolving an apparent internal contradiction that occurs throughout the SOD but becomes most visible in 7.4.2. This section, page 18, lines 9 thru 11, defines “renewable energy” as “energy from solar, geophysical, or biological sources that, in principal, can be replenished by natural processes at a rate that at least equals its rate of use (IPCC, 2011a).” However, section 7.4.2 footnote 4 (lines unnumbered) contradicts this definition, stating: “In practice, RE sources are sometimes extracted at a rate that exceeds the natural rate of replenishment (e.g., traditional biomass, geothermal energy).” The reviewer sees an opportunity for the authors to address this inconsistency, which would greatly benefit the entire SOD. The reviewers may choose to remove biomass from the renewable energy (RE) portfolio or include biomass in the RE portfolio by showing how it conforms to the RE definition. In the case that the authors choose to refer to biomass as “renewable energy,” section 7.4.2 would require an explanation of how biomass replenishment can occur in principle “by natural biological processes at a rate that at least equals its rate of use,” as indicated by the accepted definition. In this case, the authors would have to respond to at least four central points in the literature. The first deals with carbon emissions. For instance, in a Vermont study, Mica and Keeton (2012) found “that in all bioenergy harvesting scenarios, the carbon removed from stands and emitted from bioenergy generation was greater compared with equal amounts of energy produced from fossil fuels.” This result is consistent with Mckechnie et al. (2011). The second issue to address is soil quality beyond carbon – this includes other nutrients as well as soli structure and microbial concentrations. The research shows that after biomass is removed from an ecosystem, regrowth of biological material will start from a lower quality state and each subsequent harvest would degrade the biomass resource further. Outside inputs, such as fertilizers, could increase biomass quantity but violate the accepted definition’s limit of “natural processes.” Third, the definition references a rate, which requires replenishment to outpace use of the biological material. Since a tree may be burned in a minute but requires decades to regrow, section 7.4.2 would benefit from referencing a study that explains how commensurate biomass replenishment could occur over time. (Mckechnie et al., 2011). Finally, on a related note, does extracting biomass energy offset fossil fuel use? Does it expand energy supplies and lead to further growth in energy overall? See York (2012) and Zehner (2012). Mckechnie J, Colombo S, Chen J, Mabee W, Maclean HL (2011). Forest bioenergy or forest carbon? Assessing trade-offs in greenhouse gas mitigation with woodbased fuels. Environmental Science & Technology, 45, 789–795. (DOI: 10.1021/es1024004) Mika, AM, Keeton, WS (2012). Factors contributing to carbon fluxes from bioenergy harvests in the U.S. Northeast: an analysis using field data. GCB Bioenergy. (DOI: 10.1111/j.1757-1707.2012.01183.x) York, R. (2012). Do alternative energy sources displace fossil fuels? Nature Climate Change 2, 441–44	Rejected - these issues are addressed in part in Chapter 7, but also much more substantially in other chapters of AR5. Chapter 7 already links to these other chapters. The issues addressed by the commenter are VERY important, but are outside of the scope of Chapter 7 beyond how they have already been addressed, in our view. They are also outside the scope of the definition of RE. RE is defined in SRREN, for example, as a resource that, in principle, is able to replenish itself. This does not indicate that such a resource is carbon neutral, or environmentally benign (or, in practice, that said replenishment ALWAYS occurs) - those are issues separate from the definition of RE as used here. As very important issues, they are addressed in AR5 in chapter 7 (e.g. in 7.8.1 - which explicitly shows direct and indirect emissions of bioenergy sources and 7.9 - which discusses adverse side-effects of bioenergy uses) and in other chapters (Bioenergy Annex to Chapter 11), but they are not used in the definition for RE. We define RE as simply being consistent with the definition used in the previous IPCC report, the SRREN. The question, whether RE MWh replace fossil fuel MWh has been raised in more detail in another comment and is answered there.
33867	7	0	0	0	0	Education and capacity building are necessary to adopt new technologies that reduce GHG. However, education is only mentioned twice in the entire report. Education should be a priority in 3rd world countries that lack the resources available to developed countries with established RE markets.	Accepted - the importance of education now is emphasized in section 7.10.4 Human capital capacity building.
33873	7	0	0	0	0	The report should rely solely on scientific findings that are coupled with a data citation	Rejected - While it is clear that any findings summarized by the report should be based on scientific citations these cannot be constrained to quantitative ones.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33877	7	0	0	0	0	This reports has failed to address or show the advantages of geothermal energy or the long term - in stark contrast to what I found to be somewhat promotional coverage of wind, biomass and solar which is clearly evident in the text and selected figures found in the draft report .	Rejected - The space requirements for the chapter do not allow for comprehensive coverage of any single RE technology: the IPCC SRREN report therefore provides a good reference for more information on all of the RE technologies. Geothermal is mentioned in most sections of the text that addresses renewable energy, and the issues of variable RE are mentioned in several sections. More broadly, where more coverage is given to land-based wind and solar and biomass it is because of issues specific to those technologies, as well as the fact that those technologies currently contribute more and/or are growing faster than other RE technologies such as geothermal, ocean, offshore wind, etc (additionally, biomass, solar and wind technologies are generally found to contribute more to climate mitigation in the long term in IAMs, as shown in the latter sections of the chapter). Any specific cases of promotional language that do not reflect the scientific literature are addressed as per sentence-specific comments that follow. We have added one sentence on geothermal in section 7.5, noting recent developments in EGS (previously, the paragraph addressing recent technical developments in RE does not include an example for geothermal).

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33879	7	0	0	0	0	It is important to note that the geothermla energy is baseload (24x7x365), distributed, clean and dispatchable character as it can be deployed at scale with no need for storage, etc.	Noted - Due to space constraints, we are not able to add substantially more text to that which already exists on this point as we do not have the luxury to discuss each technology in depth. The environmental and low-carbon impacts of geothermal are already noted in the chapter, as is the technical maturity of geothermal (in relation to other RE technologies). Concerns with the variability of wind/solar are noted on several occasions. Though we do not very specifically note the positive aspects of "baseload" generation associated with geothermal, the same benefits come from nuclear, fossil-CCS, biomass, etc. We instead focus in the limited space that we have on those RE technologies that might impose additional challenges, namely wind/solar.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33882	7	0	0	0	0	This report does not adequately address geothermal energy's benefits over the long term when compared to RE technologies such as wind, biomass and solar. Upon request we can provide you more citations for geothermal energy, including an extensive scientific bibliography in which to borrow from	Rejected - The space requirements for the chapter do not allow for comprehensive coverage of any single RE technology: the IPCC SRREN report therefore provides a good reference for more information on all of the RE technologies. Geothermal is mentioned in most sections of the text that addresses renewable energy, and the issues of variable RE are mentioned in several sections. More broadly, where more coverage is given to land-based wind and solar and biomass it is because of issues specific to those technologies, as well as the fact that those technologies currently contribute more and/or are growing faster than other RE technologies such as geothermal, ocean, offshore wind, etc (additionally, biomass, solar and wind technologies are generally found to contribute more to climate mitigation in the long term in IAMs, as shown in the latter sections of the chapter). Any specific cases of promotional language that do not reflect the scientific literature are addressed as per sentence-specific comments that follow. We have added one sentence on geothermal in section 7.5, noting recent developments in EGS (previously, the paragraph addressing recent technical developments in RE does not include an example for geothermal).

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33883	7	0	0	0	0	It is important to note that the geothermal energy is baseload (24x7x365), distributed, clean and dispatchable character as it can be deployed at scale with no need for storage, etc.	Noted - Due to space constraints, we are not able to add substantially more text to that which already exists on this point as we do not have the luxury to discuss each technology in depth. The environmental and low-carbon impacts of geothermal are already noted in the chapter, as is the technical maturity of geothermal (in relation to other RE technologies). Concerns with the variability of wind/solar are noted on several occasions. Though we do not very specifically note the positive aspects of "baseload" generation associated with geothermal, the same benefits come from nuclear, fossil-CCS, biomass, etc. We instead focus in the limited space that we have on those RE technologies that might impose additional challenges, namely wind/solar.
32421	7	0	0			Mixed use of "ppm" and "ppmv" for CO2 concentration.	Accepted - text revised.
24281	7	1	1	111	8	The entire chapter shall be written in a consistant regionalized manner. Since this chapter mainly focus on regional comparison, it is suggested not to step into specific country analysis and use consistent comparison regionalizaion method throughout this chapter.	Taken into account - specific country analysis is avoided where ever possible. In some circumstances, however, specific countries are mentioned, if their behavior deviates considerably from that of the region they belong to.
31520	7	1	1	111	8	The entire chapter shall be written in a consistant regionalized manner. Since this chapter mainly focus on regional comparison, it is suggested not to step into specific country analysis and use consistent comparison regionalizaion method throughout this chapter.	Taken into account - specific country analysis is avoided where ever possible. In some circumstances, however, specific countries are mentioned, if their behavior deviates considerably from that of the region they belong to.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19049	7	1	1	71	31	General comments. As in the previous version, biomass energy is split into traditional and modern. The chapter infers that most traditional energy use is unsustainable. Where is your evidence? I refer you to an article I wrote in the International Forestry Review Vol. 13 (4) entitled “Supply of woody biomass in the tropics: is demand outstripping supply?” In the article, I demonstrate that accessible sustainable supply of wood from all sources is about five times annual demand. In my opinion, there should be no differentiation. A major theme of the chapter is access to modern energy, when you really mean access to electricity. Most urban people have the potential access to electricity, but some houses are not adequate enough to be connected and some electrical supply companies have not the capacity to supply electricity to all urban areas. Also, the supply may be intermittent with brown-outs. This is why many households across income groups have more than one supply source to cooking and lighting fuels. Regarding rural areas, especially in LDCs, most have access to kerosene and some to LPG/natural gas, but it is cost that is the problem. Today, the population in LDCs is 7.06 billion. By 2030 it is forecast to increase to 8.22 billion and by 2050 to 9.42 billion. What are the plans to supply these additional people (about 0.4 billion households)? People must have sufficient money to pay for electricity. In most low-income households, electricity is not a cooking fuel, and people mainly rely on biomass which is readily available for collection or purchase. Granted, per-capita income may increase at 1-2% per year, but for those that have electricity, most will not spend the additional money on electricity for cooking. Part of the chapter is devoted to carbon capture and storage, principally of CO2 from coal. However, by far the cheapest CCS is in woody biomass and forest soils (not capturing the CO2 from emissions). It can be deployed at a fraction of the costs you are suggesting for coal. Also, once full operational an annual off-take can be used for local electrical generation (up to say 10 MW) to supply rural areas with electricity. This initiative may supply many benefits, namely environmental protection, providing fertilizers to arable agriculture, feed to animals and provide non-timber forest products. It will give employment and training to (rural) people and provide them with income. Then they may be in a position to pay for commercial fuels! Please change the tenor of the argument which at present promotes the switch away from renewable biomass energy. At present up to 3 billion people use biomass energy for cooking. There will be an additional 2 million plus people by 2050. There is no way, non-biomass fuels will completely replace biomass by 2050. This is why encouraging tree planting and management etc, plus improved cooking devices should be pursued. The chapter keeps talking about switching to 'low-carbon' energy when you really mean switching away from fossil fuels. Biomass is a renewable carbon fuel and its use must be encouraged!	Taken into account - The issue of traditional versus modern biomass now is treated in Box 7.1 on LDC in a balanced way. Afforestation programs are not excluded as a mitigation option (see Chapter 11). As Chapter 6 shows, land-use change might be a very important mitigation options especially if CCS is excluded from the list of available options. S2
25472	7	1	111			40 pages of reference are too many; cut down the number of references to reduce the number of pages by 10	Rejected - an assessment have to cite the used material. References are not taken into account in the page number limit.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21085	7	10				I do not fully understand how the Table was constructed despite the explanation of the methodology or how it relates to the IEA sources. I have not examined it in detail, given that it is due to be updated. However, it seems to me to give a misleading impression of precision and I wonder if some sort of warning should be added. The comment applies in particular to the column relating to combustible renewables and the rows for Energy Industry Own Use and Losses. Most of these figures are based on estimates rather than measurement. (The IEA itself notes that the combustible renewables etc figures are questionable and probably not comparable.) In some cases, this hides substantive points of controversy discussed in the main text. For instance, the Losses recorded under Gas are suspiciously low while the Industry Own Use looks high. Since this is noted as a significant uncertainty in the Executive Summary and Sections 7.5.1 and 7.8.1 it seems odd to record the numbers without comment here. See also comments on p 33.	Rejected. The table rests on the IEA methodology, but was adjusted to the IPCC approach using direct equivalent method. Like any statistical data, it has limited accuracy. Energy industry own use and losses are statistically reported in many countries. The direct equivalent method versus alternatives will be presented in the Appendix, as it is specified in the table title.
21777	7	10				The data are useful but the synthesis presentation is a little confusing: helpful to have all primary resources grouped and colour coded (e.g., fossils, nuclear, RE), and all secondar energy carriers grouped and colour coded Currently oil products is next to crude oil (a primary and secondary energy together) but electricity and heat are at the end. It's also confusing to have conversion efficiency and losses (both expressed as %) in the same column as they are not directly commensurate.	Accepted. Table was revised to make it more clear. Additional columns were added.
19054	7	10				Combustibles given as 53.47 EJ. In chapter 10 other figures are used for combustible totals. The report should be conssistent!	Rejected. The table rests on the IEA methodology and data. If chapter 10 uses literature from other source, other year or calculated with different methodology some inconsistences may appear.
23263	7	10				Caption needs to explain imports/exports and positive/negative signs. Why does right hand column state "and losses"? Should just say "Average conversion efficiency"	Accepted. The necessary captions are placed below the table.
23605	7	100	4	100	4	Pages to be added 1327-1332	Accepted. Thank you for the page numbers.
32993	7	11				Figure misses labels under the category Primary Energy	Accepted - the figure is revised accordingly.
32994	7	11				There would also be a Ch 11 AFOLU icon under final energy to represent energy used in agriculture and forestry.	Accepted - the figure is revised accordingly.
32999	7	11	1	11	30	It could be very useful to replace the discussion of trade with a map of flows.	Rejected. Such maps would need to be given for oil, gas and coal, and would consume too much additional space.
36732	7	11	27	11	27	67% of what? total US production? US gas needs?	Rejected. The text states quite clearly: 67% of production.
32779	7	11	31	11	32	Specify global TPES from renewables in this sentence. The statistics presented throughout pages 9-11 could be tabulated and represented as pie charts for clarity. It would reduce greatly the volume of text and allow the reader to understand readily the shares of different sources in the TPES and electricity.	Rejected. The energy supply system is quite complex to be reflected in a pie chart. Contributions of RE to power generation are given as a line in table 7.1 and to TPES as another line in this table. Only some readers look just for these parameters of the global energy picture.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
35387	7	11	31		33	Biomass and waste is the first source of RE energy and it is the fastest growing, but the numbers do not clarify which is the proportion amongst the different types, and the fact that they are all included under the same category is vague and lacks proper references. The term 'waste' should include further specification- presumably it's Municipal Solid Waste, but it's been mentioned that industrial waste is used also as fuel for RE. This data would be very important to provide to avoid confusion and misinterpretations.	Noted. More detail information on RE may be found later in the chapter.
35440	7	11	31		33	Biomass and waste is the first source of RE energy and it is the fastest growing, but the numbers do not clarify which is the proportion amongst the different types, and the fact that they are all included under the same category is vague and lacks proper references. The term 'waste' should include further specification- presumably it's Municipal Solid Waste, but it's been mentioned that industrial waste is used also as fuel for RE. This data would be very important to provide to avoid confusion and misinterpretations.	Noted. More detail information on RE may be found in the later part of the chapter.
21123	7	11	31	11	51	Replace by a table	Rejected. More details on RE are presented later in the chapter. This text shows some dynamics and RE in global energy balance context.
36733	7	11	31	11	39	2.4% or 2.7% for hydro? l.31 vs. l.39?	Taken into account - comment is obsolete as underlying text was deleted due to space constraints.
36734	7	11	31	11	47	Para beginning with "Renewables contributed 13.5% of global TPES in 2010": The first sentence discusses increases in total primary energy supply (TPES) over the period 2001-2010, but at line 36 the focus shifts to increases in the period 2000-2010 and to 2005-2011 at line 45. Suggest the focus remain on one period only to help the reader retain the important trends described in this paragraph. Where different time frames are considered necessary, the reasoning for choosing those specific time frames should be noted.	Accepted.
26948	7	11	31		33	Biomass and waste is the first source of RE energy and it is the fastest growing, but the numbers do not clarify which is the proportion amongst the different types, and the fact that they are all included under the same category is vague and lacks proper references. The term 'waste' should include further specification- presumably it's Municipal Solid Waste, but it's been mentioned that industrial waste is used also as fuel for RE. This data would be very important to provide to avoid confusion and misinterpretations.	Noted. More detail information on RE may be found in the later part of the chapter.
19872	7	11	31			The second sentence should start "During 2001-2010, Global renewable TPES increased by …"	Accepted.
23595	7	11	32	11	32	Please, indicate the share of conventionnal biomass use	Accepted.
23264	7	11	32			"wind and others". What are others? Presume it is ocean energy. Either say so or delete "others'.	Noted. More detail information on RE may be found in the later part of the chapter.
23735	7	11	33	11	33	"small additional geothermal energy use". This statement is in conflict with Ch1, p11, where it is stated that geothermal energy has increased significantly.	Rejected. This statement is on increments as a share of TPES, not on growth rates.
36735	7	11	34	11	34	"sold heat" needs to be defined.	Accepted. For clarity 'sold' was deleted
19873	7	11	34			"sold" ?	Accepted.
19055	7	11	36	11	37	Traditional biomass use grew by 2% p.a. between 2000 and 2010. This trend is likely to continue as LDC population is forecasted to grow by over 2 billion to 2050. This does not seem to be recognized as the main theme of this chapter is to discourage the use of biomass, despite the fact that it will provide employment and cash to the rural poor and serve the urban poor with 'cheap' household fuel	Noted. For answer see section 7.11.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
23265	7	11	36			Change "biofuels" to "biomass" . Also line 45. (see glossary).	Accepted.
23266	7	11	37			Add after "TPES" …. "with 60% used for tradional biomass"	Accepted. Percentage have been checked
21779	7	11	38			Typo: should be developing countries	Accepted. Correction made.
21778	7	11	4	11	5	Should be oil-equivalent supply or liquid fuels supply not oil supply.	Noted. That is why oil is shown in quotation marks.
23267	7	11	45	11	47	… wind "power" . Also If solar grew 16-fold, how did "greatest" growth occur with wind power and solar thermal? Reword.	Noted. The comment is not clear. Is 4-fold slow growth? Or what?
36736	7	11	48	11	48	Even though 1 TWh is a small amount, it confuses the reader to suddenly switch from % of total to TWh. Suggest that the authors use units consistently.	Accepted.
36731	7	11	9	11	11	Suggest rewording sentence, given lack of concensus that energy poverty is the foremost supply security concern - e.g., "83 countries (over 3 billion people) import more than 75% of the oil and petroleum products they consume."	Taken into account - comment is obsolete as underlying text has been deleted due to space constraints.
26853	7	11	38	11	38	typing mistake: replace "counties" with "countries".	Editorial
26043	7	11	9	11	11	The sentence starting with "The most prominent among oil supply security…" may be deleted since issues of security of supply have not been discussed similarly in respective paragraphs discussing coal, natural gas, renewables and nuclear in the same section 7.2.2	Rejected. The point here is low-income countries' dependence on the oil import. Nevertheless this text was eliminated.
21786	7	12		15		Section 7.3 has long text-based explanations of recent trends by region and by resource which are summarised succinctly in tables/figures. Text should be used to draw out salient features of tables/figures and can be shortened substantially.	Accepted. The text mostly provides additional information to the data in figures and tables and explains drivers for the evolution observed.
26038	7	12	1	12	2	"(heavily loaded with public concerns related to safety, radioactive wastedisposal, proliferation issues, as well as high capital and maintenance costs)" RECOMMEND: Deletion. JUSTIFICATION: A reiteration of public concerns is irrelevant for this section. It is also far too much of a generalisation. The issues listed do not apply globally, attitudes to nuclear energy vary from country to country. It is therefore not appropriate to list them as such in a passage dealing with global trends.	Accepted. Major factors that prevent nuclear from global expansion are in the chapter. If no reasons for global nuclear power generation reduction between 2006 and 2012 are presented, the drivers for such developments would be unclear.
24632	7	12	1	12	2	Suggest delete text "(heavily loaded…maintenance costs)". This section is for describing trends in fuel use, not for comments on negative aspects of nuclear.	Accepted. Major factors that prevent nuclear from global expansion are in the chapter. If no reasons for global nuclear power generation reduction between 2006 and 2012 are presented, the drivers for such developments would be unclear.
36737	7	12	1	12	7	This paragraph regarding nuclear power appears to be biased. The parenthetical "heavily loaded with public concerns" is inconsistent with the unbiased rendering of statistics in previous paragraphs describing other technologies. Furthermore, the last part of the paragraph seems to indicate that the accident at Fukushima itself was responsible for a decline in nuclear power usage, whereas in reality, it was the policy changes that followed the Fukushima accident that are affecting nuclear power's output. Suggest replacing "because of Fukushima" with "after Fukushima."	Rejected. If no reasons for global nuclear power generation reduction between 2006 and 2012 are presented, drivers for such developments would be unclear. Some softer statement without "heavily" is used.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19874	7	12	1			Delete "2000-"	Accepted. Was edited
21780	7	12	12	12	13	Saying that Annex 1 countries "managed to keep emissions" down implies that this was a managed transition or change in direction, rather than it being - for example - the result of a major recession and/or warm winters. A more neutral verb should be used.	Accepted.Text edited.
21124	7	12	12	12	12	Add a footnote to explain what are the Annex I and non-Annex I countries	Rejected. It is provided in annexes and glossary.
36738	7	12	13	12	13	total "energy sector", not just supply? Or is it only supply? Please clarify.	Accepted. Clarification are made in the chapter introduction and on p. 7, fig. 7.1
32780	7	12	19	12	20	Specify which decade – it will avoid confusion for readers of this report in future years.	Accepted.
20473	7	12	2			All other technologies are given in TPES, therefore nuclear should be treated the same in order to compare. Change 12.9% power generation to 1.95% TPES.	Accepted. Was edited
23596	7	12	2	12	2	Dekte "and maintenance" . While high capital investments are indeed required by nuclear power, the maintenance costs are low enough to make nuclear power one of the most cost effective energy sources (see figure 7.10).	Accepted.
36739	7	12	20	12	22	It would be helpful to include a pie chart with the sector emission percentages from CO2, methane, NOx, etc.	Rejected. The space limits do not allow for having too many charts.
35388	7	12	22		23	Include that Municipal Solid Waste is also an important source of N2O alongside biomass-fuel. N2O emission should be taken into account according to: Astrup, T., Møller, J. & Fruergaard, T., 2010. Incineration and co-combustion of waste: accounting of greenhouse gases and global warming constributions. Waste Management & Research.	Noted. Because this is an energy chapter, N2O emissions from municipal waste combustion for heat and power generation are included.
35441	7	12	22		23	Include that Municipal Solid Waste is also an important source of N2O alongside biomass-fuel. N2O emission should be taken into account according to: Astrup, T., Møller, J. & Fruergaard, T., 2010. Incineration and co-combustion of waste: accounting of greenhouse gases and global warming constributions. Waste Management & Research.	Noted. Because this is an energy chapter, N2O emissions from municipal waste combustion for heat and power generation are included.
26949	7	12	22		23	Include that Municipal Solid Waste is also an important source of N2O alongside biomass-fuel. N2O emission should be taken into account according to: Astrup, T., Møller, J. & Fruergaard, T., 2010. Incineration and co-combustion of waste: accounting of greenhouse gases and global warming constributions. Waste Management & Research.	Noted. Because this is an energy chapter, N2O emissions from municipal waste combustion for heat and power generation are included
32781	7	12	25	12	26	Useful to say here that almost three quarters of emissions is on account of population affluence or per person consumption, with one quarter due to population growth.	Rejected. In fig 7.3 the right-hand plot displays the contribution of drivers to emission growth by decades. And clearly, the contribution of population growth has not been that large in the recent decades.
31241	7	12	25	12	30	This paragraph is unclear. Are you saying that population growth, GDP/P growth, and increasing C intensity of electricity generation contributed tendencies for 36%, 72% and 28% increases in emissions, respectively, while decline in electricity demand per unit of GDP contributed a tendency for a 45% decrease? This would seem to imply that the net effect was a 36+72+28-45 = 91% increase, but I don't think that this is correct. In any case, please clearly spell out the tendencies of the various drives in such a way that the add up to the net effect.	Accepted. Numbers are provided more clearly.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21086	7	12	25	12	30	This paragraph could be clarified. Presumably GDP growth contributed + 72% not -72% to emissions. The word "compensated" in line 27 is ill-chosen - presumably it means "offset" - and the sentence as a whole is badly drafted. The last sentence in the paragraph is also unclear - does it really refer to sector carbon intensity "relative to TPES" (which is an odd reference point) or does it just refer to the increase in sector carbon intensity? Figure 7.3 is difficult to read on my version of the text but does not, at first sight, give the same message as the text.	Accepted. Numbers are provided more clearly.
21893	7	12	25	12	30	The share of electricity generation in total energy production is increasing. Given that electricity is the only form of energy that can be produced in a low-carbon way this is opens up the opportunity for further deployment of low carbon technologies.	Noted. This is stated in line 28.
23268	7	12	25	12	26	36% + 72% = 106%!!!	Accepted. Numbers were fixed.
36740	7	12	25	12	25	"36% of additional ..... " is not obvious from Figure 7.3	Accepted. Numbers were fixed.
36741	7	12	25	12	28	Para beginning "Decomposition analysis (see Figure 7.3)" needs to be carefully checked against Fig 7.3. It appears that the greatest factor in the increase is the change in per capita GDP, followed by carbon intensity and then population. It is unclear whether the value stated in the text for change in per capita GDP is intended to be positive (as shown in the figure) or negative (as potentially implied in the text). If per capita GDP increases net carbon emissions, then "with GDP per capita - 72%" needs to be changed to "with GDP per capita responsible for 72% of the increase" or similar to avoid suggesting the change is negative. If the change is actually negative, the text needs to explain the apparent discrepancy between the text and the figure. More generally, this paragraph needs to be rewritten to clarify the key drivers, as well as the basis for describing the change (percent vs. absolute).	Accepted. Numbers were fixed.
36742	7	12	26	12	26	The phrase "with GDP per capita - 72%" is confusing -- the dash should be replaced by "of" or something that clarifies what is being conveyed.	Accepted. Numbers were fixed.
20475	7	12	27		28	change: "…compensated 45% …..increment." by "….compensated the emissions increment by 45%."	Accepted. Numbers are provided more clearly.
20474	7	12	3		4	", but only 0.5% ……previous decade" This sentence is missleading. The actual increase of TPES in EJ and the share of nuclear should be given instead.	Accepted. Was edited
35389	7	12	32		34	Delete the word' strongest' in 'strongest ever carbon mitigation policies' as obviously the policies have not prevented the general increase of emissions and it deems the sentence incoherent in itself. It can be said that much efforts have been devoted to this purpose but the results are clearly insufficient.	Noted. That is exactly what was meant. We have improved this statement.
35442	7	12	32		34	Delete the word' strongest' in 'strongest ever carbon mitigation policies' as obviously the policies have not prevented the general increase of emissions and it deems the sentence incoherent in itself. It can be said that much efforts have been devoted to this purpose but the results are clearly insufficient.	Noted. That is exactly what was meant. We have improved this statement.
26950	7	12	32		34	Delete the word' strongest' in 'strongest ever carbon mitigation policies' as obviously the policies have not prevented the general increase of emissions and it deems the sentence incoherent in itself. It can be said that much efforts have been devoted to this purpose but the results are clearly insufficient.	Noted. That is exactly what was meant. We have improved this statement.
40687	7	12	5			It is needed to present the factual basis of "0.5%" in the part "In 2011 power generation at nuclear plants globally was down by 0.5%"	Accepted. Was edited
26074	7	12	9	12	34	Reduce the enumeration of numbers. Makes the text very hard to read. Try to condense the information in a table	Noted. We have reduced the numbers. Because the section is on trends, some number are unavoidable.
31633	7	12	1	12	2	Is the parenthesis intended to convey that these issues are causal in determining the level of contribution from nuclear? These issues are mentioned elsewhere and it is not clear that they need to be repeated at length here.	Rejected. This is an introductory section, and it in brief states the drivers that prevented nuclear from expansion recently. More details are provided later in the chapter

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20714	7	12	10	12	24	Surely reference to 'embedded' emissions with some data required here.	Rejected. This topic is covered in Chapter 5. Embedded emissions are counted based on not only carbon intensity of energy, but on material intensity as well. So it touches on the whole economy and industry, not just energy systems. A cross-reference to Chapter 5 is provided to relate to this issue.
32784	7	12	8	15	25	These paragraphs contain data covering OECD/non-OECD, specific countries, changes in TPES, carbon intensity and so on. To avoid confusion, it may be better to represent the bulk of the data in a Table. This preserves clarity and allows the reader looking to find statistics quickly. This allows the prose to focus on the explanations behind the statistics and should shorten the overall Chapter.	Rejected. IPCC WGIII decided to have consistent figures on emissions by sources and regions. Therefore, tables merely duplicate them. We can hardly afford such luxury, given tight space limitations.
31634	7	12	25	12	30	This section and the first sentence in particular are unclear. The terms 'additional sector emissions', 'emission increment', 'additional emissions' and 'additional energy sector GHG emissions' are used in the paragraph. It is not clear which are interchangeable and which are distinct so clarification is needed and it may be that consistent use of terminology would suffice. NOTE: consistency in this terminology throughout the report should be striven for as there are various places where they are mixed in paragraphs. This tends to create confusionin the mind of the reader.	Accepted.Text edited.
31635	7	12	32	12	34	This sentence would be clearer if revised to read "With 3.6% annual growth in energy supply sector emissions, the decade with the strongest carbon emission mitigation policies to also had the strongest emissions growth in the last 40 years."	Accepted.Text edited.
21781	7	12	14	12	14	Consumer sectors are earlier referred to as final energy or end-use sectors. Use terminology consistently throughout.	Accepted.Text edited.
24137	7	13		13		The figure and associated table are distorted - please rectify	Noted. Was fixed.
34257	7	13				The last year on the x-axis is not shown completely	Noted. Was fixed.
31636	7	13		13		Final x-axis value should be 2010. The table below the plot is cut off and the units of the calues are not given.	Noted. Was fixed.
19056	7	13				Only one column of the sector is shown.	Noted. Was fixed.
23597	7	13				The right hand graph vertical scale shoud be labelled as in %. The units used in right hand table should be given.	Noted. Was fixed.
23269	7	13				Figure cut off. But why is decompostion figure just added on right - with no Y axis label? Is confusing and not clear for reader. Better as separate figure. Also emissions figure goes to 2009 (cut off) and decomposition goes to 2010.	Noted. Was fixed.
21782	7	13	1	13	5	Order the categories from highest to lowest as it's confusing currently (and 'Manufacture of other fuels' disappears). Inset table and graph x-axis are truncated.	Noted. Was fixed.
36743	7	13	1			The x-axis, showing 1970 and 1971 data on the same scale, is somewhat confusing. It would be better to have this as a single point (not a bar) on the main graph. Also, the end year shows up as 200 instead of the presumed 2010.	Noted. Was fixed.
36744	7	13	1			The right side of the main graph has been trimmed slightly. The table below the graph has been cut off and only shows the 70's decade. The table should show three more decades of data. The Figure should be corrected to show the complete graph and table.	Noted. Was fixed.
36745	7	13	1			The "inset figure" in the upper right does not have units labeled on the y-axis. Are these Gt CO2, or percentage increases?	Noted. Was fixed.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36746	7	13	1			Graph and sector legend are cut off	Noted. Was fixed.
35265	7	13	15	13	18	1) Per capita energy supply sector CO2 emission, as an indicator, does not reflect any specific economic or physical processes; therefore using this indicator to make comparison between different regions is meaningless. is suggested to delete “excluding China” and add the data of China into “Non-OECD Asia”.(L15-16) 2) It is not appropriate to compare a region, OECD Europe to a country (China). It is suggested to delete the sentence. (L17-18)	Rejected. This indicator is considered by many as a quite important one not for the analysis alone, but also in negotiations.
32783	7	13	15	13	17	The rates of CO2 intensity are quoted over two different periods here – is the sentence comparing annual rates or period rates?	Noted. Data in those lines are per capita 2010 emissions.
24286	7	13	15	13	18	1) Per capita energy supply sector CO2 emission, as an indicator, does not reflect any specific economic or physical processes; therefore using this indicator to make comparison between different regions is meaningless. is suggested to delete this sentence or use a relevant or meaningful indicator. 2) It is not appropriate to compare a region, OECD Europe to a country (China). It is suggested to delete the sentence.	Rejected. This indicator is considered by many as a quite important one not for the analysis alone, but also in negotiations.
31525	7	13	15	13	18	1) Per capita energy supply sector CO2 emission, as an indicator, does not reflect any specific economic or physical processes; therefore using this indicator to make comparison between different regions is meaningless. is suggested to delete this sentence or use a relevant or meaningful indicator. 2) It is not appropriate to compare a region, OECD Europe to a country (China). It is suggested to delete the sentence.	Rejected. This indicator is considered by many as a quite important one not for the analysis alone, but also in negotiations.
21784	7	13	17			tCO2 missing from 2.86 figure	Editorial - text revised.
32782	7	13	2	13	4	This sentence needs to be explained – Non OECD countries contributed all additional TPES in 2000-10. This suggests that OECD countries made no contribution to TPES in that period.	Rejected. The text says 'additional'. OECD countries contributed no additional emissions in that decade.
21087	7	13	7			The Methodology Annex explains OECD90 but doesn't make it clear whetherand how the changing composition of the OECD is reflected across the period after 1990. In the following paragraphs a number of references are therefore unclear.	Noted. Should be reflected in the Annex.
21783	7	13	7			Explain OECD90 (or use consistent region labelling throughout). Ditto in Figure 7.4 legend.	Noted. Reference should be made to the Annex.
36747	7	13	7	13	7	explain what is meant by OECD90 (i.e., does it mean the OECD in 1990?).	Noted. Reference made to the Annex.
24291	7	13	8	13	9	“By 2010, Asia had become the major emitter with 42% share, and China’s emissions surpassed those of the US" Only using data and methodologies from IEA may not be very convincing, it is suggested to use data from other international research institutes.	Noted. We used database which relies not only on IEA data, but on EDGAR and other databases.
31530	7	13	8	13	9	“By 2010, Asia had become the major emitter with 42% share, and China’s emissions surpassed those of the US" Only using data and methodologies from IEA may not be very convincing, it is suggested to use data from other international research institutes.	Noted. We used database which relies not only on IEA data, but on EDGAR and other databases.
31637	7	13	10	13	13	The focus is on Asia and there deos not seem to be particular value in mentioning the relative position of other regions. Revising the text to read "Asia accounted for 77% of additional energy sector emissions in 1990-2000, 86% in 2000-2010 and 83% overall (1990-2010) (Figure 7.4). 69% of the sector’s global total originated in the Asian electricity and heat generation sector ." would help the reader.	Rejected. We need a broader picture, not just Asia. The question is where else emissions were growing.
31638	7	14		14		The units for the values in the data table below the plot are not given.	Noted. Was fixed.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
23270	7	14				Again, y-axis label missing of right hand graph. Table units missing (though is in caption but hard to find).	Noted. Was fixed.
31643	7	15		16		Much of the text is not focussed on answering the specific question. Largely it is a repetition of information from elsewhere in the section and much of it could be cut without loss to the report. In fact a more focussed answer would be of more use to the reader. It should include some amounts of GHG and not just percentages. 5 to 10 lines should suffice and provide a saving of about half a page.	Accepted. The answer is now more question-related.
31639	7	15	1	15	4	This second sentence in the paragraph is complex and needs to be restructured to help the reader for example "Non-OECD was less affected by the recent economic crisis and its population and GDP growth accounted respectively for 89% and 78% of global increments. It contributed all additional TPES in 2000-2010, while for the OECD, 2010 TPES was slightly below the 2000 level."	Accepted. The text has been revised.
33040	7	15	1	15	25	These paragraphs refer to regions that have not been agreed for use across the AR5. Please focus discussions on common regions, as defined in Annex II.	Accepted.
24288	7	15	15	15	15	It is not approperiate to compare China and Non-OECD Asia.	Accepted.
31527	7	15	15	15	15	It is not approperiate to compare China and Non-OECD Asia.	Accepted.
20715	7	15	15	15	16	OECD Europe - if emissions 'embedded' in imports are included??	Noted. No. It is only direct energy sector emissions.
31642	7	15	23	15	24	Is this intended to mean that non-OECD emissions were 35% greater than those folrm OECD countries OR that at 35% they were greater than those from OECD countries?	Noted.This text was revised and this statement was changed.
36748	7	15	26	16	10	Tha authors make repeated use of expression "energy sector", yet the caption implies that it is only the energy supply sector.	Accepted. Text revised.
23271	7	15	27	16	32	Repetitive of text througout the FAQ. Maybe delete from main text if FAQ has to stay.	Accepted. The answer is now more question-related.
27760	7	15	33	15	35	Maybe there is an easier way to describe the high emission growth rates of the sector? This comparison is difficult to understand.	Noted.This text was revised.
30912	7	15	35	15	37	While it is important to define the range of energy outputs, which could be revised for clarity of understanding by all readers, it is also important to define end users or provide examples of who is represented by this term.	Noted. End-users are listed in the first paragraph of the secton 7.2
21787	7	15	36	15	36	Energy carriers not energy outputs. (Keep terminology consistent throughout).	Noted.This text was revised.
21788	7	15	38	15	41	Be much clearer about the extent of losses (waste heat) in the conversion sector.	Noted.This text was revised.
35266	7	15	4	15	5	It is unnecessary to break non-OECD Asia into these two regions. It is suggested to replace “Two regions - non-OECD Asia (excluding China) and China” with “Non-OECD Asia”. The categorization of regions in this chapter shall remain consistent with that in other chapters. It is suggested to integrate data of China into “Non-OECD Asia”.	Rejected. As China has become number one in emitting, it seems important to show its role in the emission growth in the energy sector.
24287	7	15	4	15	5	It is totally not necessary to break non-OECD Asia into these two regions. It is suggested to replace “Two regions non-OECD Asia (excluding China) and China” with “Non-OECD Asia”, which has no impact on the message conveyed by this sentence. In addition, categorization of regions in this chapter shall remain consistent with that in other chapter.	Rejected. As China has become number one in emitting, it seems important to show its role in the emission growth in the energy sector.
31526	7	15	4	15	5	It is totally not necessary to break non-OECD Asia into these two regions. It is suggested to replace “Two regions non-OECD Asia (excluding China) and China” with “Non-OECD Asia”, which has no impact on the message conveyed by this sentence. In addition, categorization of regions in this chapter shall remain consistent with that in other chapter.	Rejected. As China has become number one in emitting, it seems important to show its role in the emission growth in the energy sector.
33000	7	15	46	16	10	These final paragraphs could be removed to save space - the statistics contained therein are also included in underlying chapter, so this is simply a repetition.	Accepted. The answer is now more question-related
31640	7	15	6	15	8	The word neutralized is used. In this context offset appears more appropriate.	Accepted. Text has been revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21785	7	15	8			Compensated (used earlier) or offset is more appropriate term than neutralised.	Accepted. Changes made to the text.
31641	7	15	8	15	11	The phrase "managed to decouple" is used. This might be appropriate if the results had been the outcome of deliberate defined policies and actions. No evidence of this being the case is provided and it seems more likely to be a result of a fortuitous convergence of circumstances and local conditions. The lessons from the latter situation are quite different form those in the former. So it should be made clear which is considered to have been the case.	Rejected. This was result of policies and actions, such as market reforms, process liberalization, demilitarization, fuel switch in favor of gas, structural changes in the economy, substantial progress in EE, just to name a few.
26855	7	15	46	16	2	It would be more correct to differentiate low- and non- carbon technologies in this FAQ	Rejected. Cross-references to other chapters have been made.
34179	7	16	10			The sentence is completely out of context. It does not relate to the emissions issue to which the FAQ box is devoted to. I recommend to skipp it.	Accepted. The answer is now more question-related.
26075	7	16	10	16	10	Should mention the trend of the last 20 years. Should read 'In 2010 the share of nuclear energy was at about 13%. It reached a maximum share of about 17% in 1991 and has been delining gradually since 1993.' See World Nuclear Association's homepage 'Nuclear Power in the World Today'. Graph on 'Nuclear Electricity Production and Share of Total Electricity Production' .	Accepted.
20476	7	16	10			Nuclear energy's share of electricty production was around 13% in 2010 down from 16% in 2005 (IPCC AR4)	Noted.
26793	7	16	10	16	10	To keep consitensy in this box, trends of nuclear in the last years are missing.	Noted, but this text has been removed.
36749	7	16	11	20	23	This section on "Resources" needs to be reconsidered. Fossil fuels and nuclear are treated by providing resource estimates. Renewables are treated by providing technical potential estimate. These values are not comparable. While recognizing that the size of renewable resources is not as well known as the physical resources size of fossil and nuclear, there are estimates. If the authors deem renewable resources to be too poorly mapped to represent, that should be made explicity rather than providing technical potential.	Rejected: The usage adopted for renewable energy potential has wide use in the referenced publications.
34172	7	16	13			The section starts with the emphasis on uncertainty. It is recommended to start with the information that can be said with high certainty, and then add the uncertainty. In particular the classification issue of different fossil fuel endowments is clearly a point of great scientific dispute, but policy makers should first get the information where therre is little dispute and then get to the points that are more ciritcal. The quest for fossil fuel supply is surely crucial and the issue of availability of various geological classes like non-conventional oil resources is surely important for the overall potential to emit CO2 into the atmosphere.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
36751	7	16	13	16	13	Suggest substituting "resource industry" with "fossil industry" or other umbrella identifier of plural industries concerned with resources, reserves, and occurrences.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
36752	7	16	13	16	18	Consider introducing concept of Technically Recoverable Resources (TRR). See http://www.eia.gov/todayinenergy/detail.cfm?id=7190 and comment #23831.	Rejected: The distinction between reserves and resources has been made.
36750	7	16	13	17	5	This entire section on oil resources needs to be reconsidered. Recognizing the disagreements on terminology (conventional/unconventional, resources/reserves), the authors need to pick a single definition, state it and use it consistently. It will need to be acknowledged that differences of opinion on that definition exist, but that would be significantly preferable to the mix of terminology in the current version.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36753	7	16	20	16	24	Suggest the authors clarify what is meant in this dicussion. The capture and use of coal mine methane (versus CBM) would result in lower GHG emissions. CMM is classified as an uncoventional gas.	Rejected: This section addresses fossil fuel resources and lists their estimated carbon content.
31644	7	16	22	16	24	Whilst these resources may result in higher GHG emissions it is not necessarily a function of the fuel itself. Coal bed methane has the same characteristics as the methan in NG. The key is the extraction and utilisation techniques applied. In some cases (abandoned mine methane, coal mine methane) collection and utilisation reduces GHG emissions. So it would be more appropriate to say "... including potenitally higher GHG emissions than might result for use of conventioanl analogues of these resources".	Rejected: The work of Brandt and Farrel (2007) as well as others makes it clear that for many unconventional hydrocarbons additional energy must be put in to recovering the fuel and that should lead to higher GHG emissions. Perhaps the sentence could be written to make it clear that there is the potential for higher GHG emissions from the core production process as well as from not mitigating fugitive emissions but there is an important point here that some lower grades of fossil fuels will require more energy to produce that should not be lost. Brandt A, Farrell A. "Scraping the bottom of the barrel: CO2 emission consequences of a transition to low-quality and synthetic petroleum resources." Climatic Change. 2007;84:241-63. See also Dooley J, Dahowski R, Davidson C. "The potential for increased atmospheric CO2 emissions and accelerated consumption of deep geologic CO2 storage resources resulting from the large-scale deployment of a CCS-enabled unconventional fossil fuels industry in the U.S." International Journal of Greenhouse Gas Control. 2009;3:720-30.
36754	7	16	22	16	22	Suggest that if the authors intend "hydrate" to mean "gas hydrates" that this be made explicit.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
36755	7	16	23	16	24	It is not clear that the statement "Pose different environmental challenges including higher GHG emissions." is true in all cases. Suggest that it be qualified appropriately.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
30438	7	16	24			"higher GHG emissions" - not all unconventional resouces will necessarily have higher GHGs. For example, shale gas extraction has a much lower GHG footprint than heavy oil. You might say "potentially higher GHG emisisons" in some cases	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
25935	7	16	28	16	28	(knowledge, in broad sense, i.e., including not only technological innovations, but also about management and all kind of concepts, criteria and experiences towards a more rational and sustainable development and use)	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
26902	7	16	3	16	5	This is the first time the energy chapter states that per capita emissions are lower in developing nations. This fact deserves to be presented much more prominently than in an FAQ, and should be included at a higher level in the chapter, perhaps even in the Executive Summary along with the statement about Annex I emission levels (page 4, lines 12-14).	Taken into account - per capita emissions now are treated explicitly in 7.3. There is no discussion of the difference between Annex 1 and non-Annex 1 in the ES. This belongs to chapter 5 and is discussed there.
31645	7	16	30	16	31	The observation re: peak oil or gas is important but not explained disussed until later in the section. So it would be appropriate to revise the parenthesis to read "fixed quantities inevitably lead to concepts such as peak oil or gas which are discussed below".	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
36756	7	16	33	16	33	Suggest that instead of "reserve" the authors use "resource estimates". The chapter argues, correctly, that "reserve" is a very restricted definition. If so, it is not clear how they can now be described as uncertain.	Rejected: use of the terms 'reserves' is consistent with definition given.
36757	7	16	33	16	33	This is not a reason that reserve estimates are "fraught with uncertainty". It is a reason why reserve estimates can change quickly. Reserve estimates are reserve estimates both before and after the change, by definition.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
26903	7	16	34	16	37	Uncertainty over reserve and resource estimates affect all fossil fuels, not just coal - this point should be made at a high level to address all fossil fuels. Similarly, uncertainty in environmental policy and economic, legal, and transportation constraints are significant for all fossil fuels, particularly in the case of natural gas, as it is not clear how the prices of gas will evolve.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
26076	7	16	34	16	47	Please uns EJ not ZJ as a unit. This is in line with your own table 7.2. The use of ZJ is extremly uncommon!	Accepted: Units altered.
21789	7	16	34	16	47	Table 7.2 reports in EJ but text reports in ZJ. Keep metric consistent (recommend EJ as the more familiar unit). It would also be useful to include carbon emission factors (C/GJ or C/kg) in text and/or Table 7.2	Accepetd: Units altered.
31646	7	16	34	16	38	It would be appropriate to mention here the potential for accessing some coal reserves through in place processing, that is through underground coal gasification and potenitally reclassify some resources as reserves.	Rejected: Space limits discussion of this point.
36758	7	16	35	16	35	Suggest introducing the term "energy density" here. By itself, "energy contents" is not meaningful. GJ/t is energy density.	Rejected: section deals with energy estimates in fossil fuels.
34173	7	16	36			The indication of uncertainty should be narroed down. The presentation of the uncertainty leaves too much space for interpretation. The sentce afterwards brings this more down to the point, when the totoal coal reserve is delimited. Hence, I recommend first to present what is known with a higher degree of certainty and then move to the reasons for the uncertainty.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
19057	7	16	36	16	36	Energy of coal 5-30 GJ/t. the usual range is from 25-38 GJ/t. Only if there is a high concentration of non-combustible material will the energy value be 5 GJ/t.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32785	7	16	37	16	38	Table 7.2 gives energy values in EJ, rather than ZJ. ZJ is not a unit commonly encountered in the literature. A standard form notation may be useful to help the reader here. Else, maintain the use of EJ as the units throughout the text.	Accepted: Units altered.
32786	7	16	39	16	45	References needed.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
26904	7	16	39	16	41	The statement that "'peak oil' is imminent or has already been passed" is not based on any citation, and appears to come out of nowhere. This sentence should be removed - it is an advocacy position.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
21894	7	16	39	17	2	It is clear that when it comes to gas and oil unconventional resources are taking over almost worldwide. Conventional oil and gas in Europe is in persistent decline.	Taken into account: The rise of unconventional fossil fuels is addressed in the text.
33763	7	16	4			… biomass remains an important …	Noted. FAQ box was revised.
27761	7	16	4	16	5	This sentence has no connection to the rest of the box.	Accepted. The answer is now more question-related.
36760	7	16	40	16	40	Define "peak oil."	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
36759	7	16	40	16	41	If the authors are convinced that peak oil is imminent/passed, they need to include supporting citations. This conclusion is highly controversial in a way that the text does not acknowledge.	Accepted: additional references added (Sorrell et al 2012, Owen et al 2010, Hook et al 2009)
36761	7	16	41	16	44	"essentially doubling reserves" confuses the reserve/resource definition issue. Suggest deleting this addition. Alternatively, the authors could say "doubling potential future reserves." "production will begin to decline" is confusing at best. This needs clarification.	Accepted: Text altered.
19875	7	16	45		47	Table 7.2 needs to be consistent with the numbers in this sentence.	Accepted: Table 7.2 has been revised.
32688	7	16	47	17	2	The statement "Oil prices in excess of $80 per barrel are probably needed to stimulate investment in unconventional oil development (Engemann and 1 Owyang, 2010; Rogner et al., 2012; Maugeri, 2012)." does not fit to what is shown in Fig 7.6 (p. 18). There is shown, that "production cost" (for oil shale) starts with about 30 $/bbl and ends at about 90 $/bbl.	Taken into account: Figure 7.6 has been removed.
36762	7	16	47	17	2	This ($80/bbl) is uncertain. Please verify and update information. Many companies with $60/bbl or lower thresholds appear to invest in these resources.	Rejected: the figure quoted is based on the published studies referenced in the text.
19876	7	16	47			$80. Although I agree with this figure it is not consistent with Fig 7.6	Rejected: Figure 7.6 has been removed.
33764	7	16	7			… the dominant share …	Noted. FAQ box was revised.
34174	7	16	34			The uncertainty of coal reserves is highly disputed. The authors are recommended to indicate that several authors have raised doubts about the recoverability of the entire coal reserve at (very) low costs. See e.g. Table 1 in http://pubs.usgs.gov/fs/2012/3143/fs-2012-3143.pdf	Rejected: This is what the literature suggests (see GEA, 2012)
26905	7	16				Unconventional oil and gas, e.g. shale oil and shale gas, could be discussed more in this section, especially since they are what's really "new" in the fossil fuel field since the last IPCC report. Figure 7.6, for instance, does not seem to include production cost for shale oil, skipping straight from conventional oil to tar sands & heavy oil.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26044	7	16	11	20	23	This section was supposed to come before section 7.2 on "Energy production, conversion, transmission and distribution". I feel it is necessary to understand resources and resource availability prior to energy production, conversion, transmission and distribution. Section 7.4 also explains very well some terms such as conventional and unconventional resources which are just mentioned and not explained in preceeding sections including 7.2	Rejected: The section headings are fixed.
23923	7	16	13	16	14	This statement is incorrect and should be removed. There is broad alignment betweem COGEH and SPE-PRMS definitions for reserves and resources. The SEC, CSA and other financial regulatory bodies require consistent and accurate definitions of reserves/resources/ as do company Boards of Directors, Stakeholders, bankers, lawyers and so on. Standards are maintained by the Society of Petroleum Evaluation Engineers, Calgary. Standards are accepted by CSA. ASC, APEGGA.	Accepted. The statement has been removed.
32788	7	17		17		It is useful to indicate which data comes from which source in this table.	Rejected: The references are cited in the table caption.
31242	7	17				Why is the estimated conventional oil resource smaller than the estimated reserve? It should be the other way around.	Taken in to account: This is a result of the definitions used.
25376	7	17	11	17	15	This part lacks good balance, listing only potential of unconventional natural gas. It should also be described that unconventional natural gas such as shale gas has environmental and technical issues, and its development is not advanced in some areas.	Rejected: This section addresses fossil fuel resources and lists their estimated carbon content.
32787	7	17	11	17	13	References needed.	Taken into account: Section 7.4 has been redrafted and this comment has ben taken into account during then redrafting.
21102	7	17	19	17	23	This paragraph should mention explicitely the gobal carbon budget allowed (by 2050 for example) to remain consistent with Cancun agreement	Accepted: The text has been modified to be relative to the Cancun Agreement.
36764	7	17	19	17	19	The sentence is poorly written. Consider rewriting, to make the point more explicitly.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
33002	7	17	21	17	23	In and of themselves, the reserves don't present a challenge to cc mitigation targets. It's rather if the fuels contained in those reserves are burned that we have a challenge - please clarify in text.	Rejected: The context is clear given the opening sentence of the final paragraph.
36765	7	17	21	17	23	Reserves do not present a challenge -- the way that energy is used presents the challenge. Please rephrase.	Rejected: The context is clear given the opening sentence of the final paragraph.
21790	7	17	22			Is the target 450 CO2 or 450CO2-eq?	Accepted: text has been altered to reflect the Cancun Agreement.
36766	7	17	24			Suggest expanding this table with more detail (e.g., kinds of unconventional oil) or at mentioning GEA (2012) and WED (2010) as sources of additional information.	Rejected: Space limits do not enable this level of distinction to be made.
36767	7	17	24			Please check the figures for conventional and unconventional oil. The reserve estimates for conventional oil are higher than the resource estimates,which seems backward. Reserve estimates are lower for unconventional oil, conventional and unconventional natural gas, and coal compared to resource estimates.	Taken in to account: This is a result of the definitions used.
34175	7	17	3		5	Please clarify what the long-term supply cost function represents. It is important to make the conceptual assumptions explicit and transparent for the policy makers in this particular case.	Rejected: The section focus is resources not costs.
34177	7	17	6		15	Please qualify the very high number on unconventional gas reserves and that this is related to recent revisions in assessments. This is a major change to AR4, but also it is highly disputed as national assessment bodies like the US-EIA already reduced their expectations.	Rejected: This is what the literature suggests (see GEA, 2012).

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26077	7	17	6	17	15	Please make note of the recent reassessment of unconventional gas. Which sees the recent US development as an unrealistic overestimate. See: Huges, David Energ: A reality check on the shale revolution. In Nature 494, 307-308 (20 February 2013)	Rejected: As noted for response 496 above, there is variation in the avilable assessments and not all these assessments can be included.
36763	7	17	9	17	9	"geophysical" It is much more than geophysical in a strict sense. It is as much geochemical (radioactive decay) which is NOT geophysical. Suggest using geothermal as a more inclusive term.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
24634	7	18				Completeness - suggest include processing costs in this figure to avoid misrepresenting the supply potentials of existing fossil fuel sources	Rejected: Figure 7.6 has been removed.
33001	7	18				Please update to 2010 US dollars to conform to AR5 standard.	Accepted.
23272	7	18				Two boxes without labels. If meant to be two cost ranges for EOR or oil, merge into one box.	Rejected: Figure 7.6 has been removed.
21101	7	18	1			As this is a climate report (not an energy report), the figure should include a carbon content horizontal scale for these ressources (in addition to the energy content scale)	Rejected: Figure 7.6 has been removed.
32689	7	18	1	18	5	A general assessment of Fig. 7.6 and the source8s) it is based on is forwarded in an extra email, by Hans-Jochen Luhmann, also Wuppertal Institute for Climate, Energy and Environment, Confirmation Number: 2666	Rejected: Figure 7.6 has been removed.
36768	7	18	1			The cost numbers in this figure are inconsistent with the main text.	Rejected: Figure 7.6 has been removed.
23274	7	18	11			Add to footnote: "……. fuels when providing similar energy services."	Accepted - addition inserted in footnote.
20445	7	18	12	18	12	Ocean wave energy and tidal stream energy could be mentioned, explicitly, as forms of ocean energy.	Rejected - do not have the space to mention conversion technologies here for ocean, as that would then also require similar treatment for all of the other forms of RE.
20716	7	18	14	18	16	It should be mentioned that the BP source cited includes Venezuelan heavy oil, Canadian tar sands, and for five key Middle East OPEC producers oil reserves which are way below 90% probable - likely barely 50% - partly as a result of incentive provided by OPEC quota arrangements over past 30 years. Thus the figures are grossly over-stated.	Rejected: the BP report is only one of many referred to in constructing the fossil fuel data. The reference to Rogner 2012 (chap 7 of GEA 2012), discusses these in detail.
21792	7	18	19			What questions are raised about the validity of bottom-up technical potentials for RE?	Rejected - space constraints do not allow us to get into the details in the text, but the citations can be reviewed for those specifics.
32789	7	18	23	18	26	References needed.	Accepted - reference to SRREN has been made more explicit.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20717	7	18	23	18	29	It should be made clear that technical potential is a highly theoretical concept, the reality is that the challenge is likely to prove insuperable - even for solar. Thus 10,000X in theory has to be discussed in terms of the realities of CSP + UHVDC transmission + PV across large areas and disparities of irradiation.	Accepted, in part - this issue is addressed to some degree on page 19. However, in addition to the issues noted in that paragraph already, we have added transmission as well. We have also added a bit more qualifying language to the first paragraph section to put the concept of technical potential into the broader context of what might be considered realistic potential.
26906	7	18	25	18	26	This sentence addresses current global energy demands, but what we really care about is future energy demands. Addressing the global technical potential for RE to provide for future global energy demand would be more relevant and helpful.	Rejected - this requires some assessment of future energy demand, which we would rather not judge in Ch 7. That said, a reader looking at what was Figure 7.7 (now moved to section 7.11) could easily ascertain that in TOTAL, RE (especially solar) also exceeds any realistic assessment of future demand.
27762	7	18	25	18	26	Please highlight the part: "the total global technical potential for RE as a whole is substantially higher than current global energy demands". This is one of the main messages of section 7.4.2.	Rejected - there is no need to highlight one aspect of the text, especially since there are many important nuances to this statement that are addressed later.
36771	7	18	26	18	26	The second "7" in "Figure 7.7" seems to be bold.	Accepted
19058	7	18	29	18	29	Footnote 4. In practice --- (eg traditional biomass and geothermal). The carbon store may be reduced due to land use changes and degradation. Generally, the annual growth of wood is much more than the rate of extraction. It is (subsistence) population increase that is a major cause of tree removal to open up more land for agriculture.	Rejected - key points, but better addressed elsewhere in AR5, not in the definition of RE.
21791	7	18	7			Reference should be to original Farrell & Brandt 2008 article (and GEA citations should be to corresponding chapters, in this case, Chapter 7 on Energy Resources and Potentials).	Rejected: The reference Rogner et al 2012 references GEA chapter 7 in the reference list and this provides a comprehensive overview of fossil fuel resource potential.
20542	7	18	9	18	12	Should clarify that source of tidal energy is principally lunar gravity, with a smaller solar gravitational component.	Taken into account - sentence eliminated, so comment no longer relevant.
35430	7	18	9		10	It should be noted that according to this definition of RE, energy produce by combustion of Municipal Solid Waste should not be considered RE, as 'waste' per se, despite being made of fossil and biogenic carbon, it's made in the form of products, which involve Life Clycle Emissions that should be considered as well.	Noted - Due to space constraints, this specific line has been eliminated. Note, however, that the non-biogenic portion of MSW is addressed in Ch 10, not Ch 7.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25705	7	18	9	18	12	This part should include "atmospheric heat" as renewable energy (RE) because the EU direction of "Promotion of the use of energy from renewable sources" and Japanese Law of "Sophistication of Energy Supply Structures" do so. Atmospheric heat can be utilized through heat pump technology and be considered as renewable energy, as described in (UNIDO, page37). This literature is listed in the No17 line of this table.	Taken into account - sentence eliminated, so comment no longer relevant.
21088	7	18	9	18	11	If this sentence is included, it should spell "in principle" correctly. But I doubt if the defintion in the sentence is helpful anyway. As the footnote points out, biomass and geothermal energy are often (probably generally) exceptions. But there are also current debates over, for instance, wind power which has local weather effects (mixing hot and cold air at night) and possible wider effects when deployed at a very large scale (lowering global wind speeds). There is probably no need to get into these arguments, but since the definition either does or could exclude large amounts of renewable power it seems better to omit the sentence entirely.	Accepted - we have eliminated the sentence, though we have retained the footnote, somewhat revised
23273	7	18	9	18	17	Much of this is well known so not needed. Could add to glossary if necessary.	Rejected - we have eliminated the first sentence, but retained the rest in part because of other comments that wish to retain this text as critical to understanding the concepts used in the section.
26938	7	18	9		10	It should be noted that according to this definition of RE, energy produce by combustion of Municipal Solid Waste should not be considered RE, as 'waste' per se, despite being made of fossil and biogenic carbon, it's made in the form of products, which involve Life Clycle Emissions that should be considered as well.	Taken into account - sentence eliminated, so comment no longer relevant. Also note that issues of MSW are addressed in different chapters of AR5 (Ch 10, industry, as well as the bioenergy annex for the biogenic portion of MSW).
33003	7	18				This section focuses strictly on technical potential. Why? It would also be useful to mention theoretical potential of REs, or simply reference the numbers presented for theoretical potential as presented in the SRREN.	Rejected - theoretical potential has even less practical value than technical potential, and many reviewers expressed a desire to eliminate that text in the previous round of comments. Space constraints are also severe.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
29177	7	18		19		Comment on Technical Potential of RE - For most renewable energy sources the amount of energy that is recoverable in the engineering sense depends on the cost you are prepared to pay for that energy and the degree that you are prepared to compromise the efficiency of the plant that you install. As extra cost and lower efficiency implies extra materials are used somewhere, which normally requires extra energy to produce, the real engineering potential for energy recovery from these sources can be much less than in the table (figure 7.7). This is especially the case with wind where you can only extract the maximum amount of energy by producing large amounts of capital items (turbines) and putting these close together (a scenario where the efficiency of extraction decreases). If the table is based on the premise that cost and materials used to extract the energy are not issues then it should be made explicitly clear in the discussion otherwise 'technical potentials' could be used to justify inappropriate investment in technologies that have a technical potential that could only be reached by employing systems with very low efficiency of energy extraction. Adding the point that the technical potential may not be realisable at reasonable economic cost and extraction efficiency to figure 7.7 legend and discussion would be worthwhile.	Accepted (in part) - the underlying sources address this issue differently, e.g., by assuming different turbine spacing for wind projects, as noted indirectly in the opening paragraph. This broader issue is addressed in the final paragraph of the section as well, at least indirectly. But, we have now added some additional text to the section as a whole to place "technical potential" within its broader (economic / practical) context, though due to space constraints, we have necessarily kept these caveats limited and brief.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25151	7	18				**Section 7.4.2, total global potential of renewable energy, open to critique for highlighting trivial data and overlooking relevant challenges. (affects the Summary for Policymakers, page 17, lines 5-13 and the Technical Summary, page 32, lines 33-36) Section 7.4.2, page 19, lines 11-13, reads: “Considering all RE sources together, the estimates reported by this literature suggest that global and regional technical potentials are unlikely to limit RE deployment even with aggressive GHG reduction goals.” This statement highlights the focus of Section 7.4.2 and is rendered in Figure 7.7. However, as has been stated elsewhere, this statement will appear to readers as roughly akin to stating that “the technical potential of rocks on the planet is unlikely to limit the ability of constructing everyone a castle.” This line of inquiry leaves section 7.4.2 open to a number of critiques, outlined below. Near the end of this comment, the reviewer also presents an opportunity for the authors to strengthen their commendable analysis at the end of 7.4.2. First, the limits of deploying RE are not of the same nature as the limits of fossil fuels. Fossil fuels are largely subject to fuel extraction limits but solar and wind technologies are not. A critic could identify Figure 7.7 and the related assessments as a red herrings, i.e. containing figures that may be accurate but are irrelevant and/or diversionary. The models (IPCC, 2011a; Fischedick et al., 2011; Verbruggen et al, 2011; M Jacobson and C Archer, 2012) referenced in 7.4.2 may well represent nominal energy levels in various systems. But, it is currently the responsibility of the authors of 7.4.2 to determine if those assessments are relevant. The current draft does not present why said assessments are relevant but does provide numerous examples of why they are not. Second, assessments of nominal energy levels leave Section 7.4.2 open to being critiqued for overlooking or underplaying relevant limits. Following the aforementioned analogy, the limit to building castles is not rocks, but rather financial costs, which can be broken down into labor and ultimately energy costs for food, shelter, transportation, extraction, and so fourth. Similarly, the limits to solar and wind systems are minimally subject to aggregate sun and wind limits and primarily subject to localized and temporal limits. More importantly, they are subject to financial limits demonstrated through practices of RE deployment, as stated elsewhere in Chapter 7. Under current global economic arrangements, finances are in turn closely linked to material resource extraction, primarily fossil fuels. Therefore, this poses a fossil fuel constraint to deploying solar cells and wind turbines that is presumably significantly below the limits posed by aggregate access to sunlight and wind. Third, Figure 7.7 is open to various critiques. It compares energy potentials of varying qualities. For instance, it displays hydropower, which is a dispatchable supply against wind power, which is not dispatchable. To make a transparent comparison, intermittent sources would have to be adjusted for storage or concurrent fossil fuel supply. Figure 7.7 also displays global demand and supply metrics, largely fulfilled by fuels that are dense, storable, portable, fungible, and transformable. Figure 7.7 compares these thresholds to energy sources that are not characterized by such qualities, or are characterized as such to a different degree. Figure 7.7 is also open to the more fundamental relevance critique mentioned above. Finally, Section 7.4.2 in its current form could be critiqued for containing an apparent internal contradiction between the discussion of “global technical potential” for RE and the presented definition of “technical potential.” Section 7.4.2, page 18, lines 12-14, defines the technical potential for renewable energy (RE) as “the amount c	Accepted in Part, Rejected in Part - There are indeed many limitations to the concept of technical potential for RE. The existing text already addresses these limitations to a significant degree, and many of the possible constraints to RE are addressed in more detail elsewhere in chapter 7 and elsewhere in the AR5 text. We have now included even more text describing the limitations of technical potential for RE, but we cannot simply eliminate treatment of the concept as a whole, as this section was agreed by the IPCC plenary. We also believe that there is some (limited) value to technical potential: namely, not all potential mitigation technologies even have the theoretical ability to play a large role in climate mitigation. So, it is useful to report on the literature that some of the RE techs can (and in total, also can), at least theoretically, contribute a sizable amount: in this sense, the authors DO BELIEVE that this literature is relevant, and that is WHY it is included in this section and why we opt to retain the Figure despite its limitations (note that the figure has now been moved to Section 7.11, however, and to increase its value we have altered the figure to compare tech potentials with IAM deployment estimates)- the figure is retained in a different form, and in a later section, because the basic point that Resource Potential is NOT the primary constraint for RE as a whole is an important one. That is not, of course, to say that RE WILL in fact contribute sizably - that issue is addressed later in
24633	7	18	8	18	22	This paragraph does an excellent job of setting out the concepts and introducing the various technologies. It should be kept if the chapter is shortened	Noted, though some inherent shortening was required in order to achieve the necessary page limit.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36769	7	18	8			Section 7.4.2, total global potential of renewable energy is subject to substantial critiques (this also affects the Summary for Policymakers, page 17, lines 5-13 and the TS, page 32, lines 33-36) Section 7.4.2, page 19, lines 11-13, reads: "Considering all RE sources together, the estimates reported by this literature suggest that global and regional technical potentials are unlikely to limit RE deployment even with aggressive GHG reduction goals." This is a summary of the point more broadly argued in Section 7.4.2 and rendered in Figure 7.7. However, this will appear to readers as roughly akin to stating that the technical potential of rocks on the planet is unlikely to limit the ability of constructing everyone a castle. First, the limits of deploying RE are not of the same nature as the limits of fossil fuels. Second, assessments of seemingly unimportant nominal estimations leave Section 7.4.2 open to criticism for overlooking or underplaying relevant limits. Third, Figure 7.7 compares energy potentials of varying qualities without acknowledging differences in dispatchability, need for concurrent backup supply, portability, fungiblility, and density. Finally, Section 7.4.2 in its current form could be critiqued for containing an apparent internal contradiction between the discussion of "global technical potential" for RE and the presented definition of "technical potential." I.e., Figure 7.7 along with the cited models (IPCC, 2011a; Fischedick et al., 2011; Verbruggen et al, 2011; M Jacobson and C Archer, 2012) imagine potentials that are outside the social, physical, economic, and political factors inherent in demonstrated RE technologies and practices noted later in 7.4.2 (Adams and Keith 2013). Suggest removing the discussion on "total global potentials" and strenghtening the analysis near the end of 7.4.2.	Accepted in Part, Rejected in Part - see lengthy response to comment above (comment 25151).
36770	7	18	8			Including biomass in the RE portfolio creates an internal contradiction The authors have an opportunity to greatly strengthen the Second Order Draft (SOD) by resolving an apparent internal contradiction that occurs throughout the SOD but becomes most visible in 7.4.2, which defines "renewable energy" as "energy from solar, geophysical, or biological sources that, in principal, can be replenished by natural processes at a rate that at least equals its rate of use (IPCC, 2011a)." However, section 7.4.2 footnote 4 (lines unnumbered) contradicts this definition, stating: "In practice, RE sources are sometimes extracted at a rate that exceeds the natural rate of replenishment (e.g., traditional biomass, geothermal energy)." Suggest the authors to address this inconsistency, which would greatly benefit the entire SOD. The authors may choose to remove biomass from the renewable energy (RE) portfolio or include biomass in the RE portfolio by showing how it conforms to the RE definition.	Noted - sentence eliminated, so specific comment no longer relevant. We define RE the same way as the IPCC has in the SRREN. To conserve space, we do not go into the details of this, but the relevant issues associated with biomass are addressed elsewhere in the AR5 (not in the definition of renewable energy, but instead in Chapter 11 and in various places in Chapter 7 to a lesser degree).
31243	7	19				I suggest replacing the horizontal lines showing 2008 supply with lines showing the 2010 supply, for consistency with other parts of the chapter, which generally refer to 2010 as a baseline for comparison.	Rejected - this figure is directly from the SRREN. The figure has now, however, been moved to later in the chapter, and adjusted for that purpose.
26625	7	19				Definition of technical potentials should be explained as described in SRREN SPM, i.e. "Definitions of technical potential often vary by study. “Technical potential” is used in the SRREN as: The amount of RE output obtainable by full implementation of demonstrated technologies or practices. No explicit reference to costs, barriers or policies is made. Technical potentials reported in the literature and assessed in the SRREN, however, may have taken into account practical constraints and when explicitly stated they are generally indicated in the underlying report.	Rejected - these points already appear to be paraphrased in the existing text, so it does not seem necessary to make any additional adjustments or clarifications.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19059	7	19				You have the biomass potential from 50EJ to 500 EJ/yr. In Table 7.1, present consumption for biomass energy is already 53.47 EJ/yr: this is more than the lower limit of 50 EJ and is growing. Net primary production of biomass is 4 ZJ of which 2 ZJ is from land plants. So the upperlimit of 500 EJ should be achievable. The NPP in tropical forests is over 500 EJ!	Rejected - the underlying SRREN report from which this figure derives expains why this is the case, and we do not have the space availability to repeat that text here (it relates to the concept of sustainable biomass- see the SRREN).
33041	7	19				If possible, it would be useful to update this figure to include studies from 2011, 2012 and 2013. If no further studies have been done since the SRREN, this would need to be mentioned.	Rejected - though there may be some updated studies, the effort required to coordinate an update is not worth the time at this late date. This is especially the case since the substantive value of such technical potential estimates is quite limited, as we make clear in the text.
19877	7	19				It is not clear why solar and wind are treated differently in this chart.	Accepted - We are not sure that we understand the comment here. Perhaps the concern is that solar is judged based on primary energy and wind based on electricity? If so, the reason is that solar often produces heat or electricity, and can also provide fuels, while wind almost always produces electricity. More details on this are offered in the SRREN, but we have summarized in the notes under the table.
21793	7	19	1	19	6	It would be helpful to show these data in a way which was compatible with / more easily comparable with Table 7.2 on the resource potentials, so a like-for-like picture of technical potentials - current utilisation - cumulative historical utilisation can be drawn.	Rejected - While this would be desirable, as noted in the text, we are not comfortable that the RE tech potential estimates available in the scientific literature are really comparable to the fossil or nuclear resource estimates. As such, we do not believe that these figures should be compared on an "apples to apples" basis. On current usage, by RE resource type, this is included in the underlying SRREN citation, with summary total figures also provided earlier in Ch 7.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36772	7	19	1			The divisions in this diagram (electricity, heat, primary energy) are not explained in the text or in the caption. It is unclear why biomass and direct solar energy are in the "Primary Energy" category, while geothermal energy occupies spaces in both "Heat" and "Electricity." The estimated technical potential of ocean energy, compared to the other forms, seems doubtful...does this take into account harvesting over the entire ocean's surface? It would seem that the near-shore opportunities for ocean energy are significantly smaller than terrestrial biomass, wind, and solar energy. If ocean energy is based on a total-ocean analysis, is wind energy compared on roughly equal footing? This needs to be clarified.	Accepted, in part, Rejected in part - A small amount of text has been added for clarification on the heat/electricity/primary energy issues, but more details can be found in the underlying SRREN citation and the documents cited within that report. We note clearly in the text that the data are not fully comparable across technologies, with more details in the SRREN. Space constraints do not allow us to detail the methods used in the individual studies summarized here, e.g., on ocean energy estimates (one of the reasons for the VERY broad range of estimates on ocean energy provided in the figure is exactly the issue noted by the commenter), or to describe the specifics of comparability or lack thereof: those details must be left for the SRREN due to space constraints.
23275	7	19	13			Could addGEA, 2012 as a reference.	Accepted
34791	7	19	18	19	20	I am a bit surprised of this sentence. I can understand that hydropower and bioenergy are mature technologies, already cost competitive but site specific (i.e. they need a lower CO2 price to be competitive with other thermal technologies). Ocean energy (except tidal ones like La Rance) are less mature so according to me when carbon constraint is increasing ocean energy should also? Only 1/4 of the world hydropower potential has been developed. I don't think that the technical potential will be the limitative issue ... Source?	Rejected - under aggressive carbon reduction scenarios, the vast majority of primary energy needs to come from very low-carbon resources (as documented elsewhere in AR5). At such aggressive deployment scales, the technical potential of some resources may indeed limit their deployment, as can be seen in Figure 7 when comparing resource potential to global electricity and primary energy demands (others such as solar cannot plausibly be limited by technical potential). This does not mean that there is not significant potential for growth from the present, but only that one cannot rely on these technologies alone to achieve aggressive carbon mitigation.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21794	7	19	18	19	32	This appears rather imbalanced: fossil fuel sections mainly covered estimates of resources, whereas RE section mainly covers reasons why resource exploitation may be constrained. This section can be shortened. (See also page 20, lines 22-23, where resource exploitation constraints are simply referenced elsewhere). It is important to keep the coverage of each mitigation option balanced and similarly structured.	Rejected - the context of this paragraph derives from previous paragraphs, which indicate that in aggregate RE tech potential is unlikely to limit deployment. But, this is not true for a number of individual technologies in individual regions, and also ignores the fact that there may be many other deployment limits that do not relate to technical potential per se. Many reviewers wish that we add more text to this paragraph, while others want us to downplay the paragraph. In the end, we choose to "split the difference" and leave the paragraph largely in its earlier form to accommodate both sides of this debate, acknowledging that this creates a slight lack of parity in comparison to the nuclear discussion in particular.
22548	7	19	18	19	32	this paragraph sounds like a demotivating and quite negative argument going agaisnt the deployment of RE - should the flavour of this paragraph be this negative?	Rejected - the context of this paragraph derives from previous paragraphs, which indicate that in aggregate RE tech potential is unlikely to limit deployment. But, this is not true for a number of individual technologies in individual regions, and also ignores the fact that there may be many other deployment limits that do not relate to technical potential per se. Many reviewers wish that we add more text to this paragraph, while others want us to downplay the paragraph. In the end, we choose to "split the difference" and leave the paragraph largely in its earlier form to accommodate both sides of this debate, acknowledging that this creates a slight lack of parity in comparison to the nuclear discussion in particular.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
35379	7	19	26			When it says 'e.g. Biomass' it should include 'and Municipal Solid Waste'.	Rejected - biomass is provided only as an example here; there is no need for additional examples as there may then be on end to the additional examples provided. Also note that non-biogenic MSW is addressed in Ch 10, not Chapter 7.
35431	7	19	26			When it says 'e.g. Biomass' it should include 'and Municipal Solid Waste'.	Rejected - biomass is provided only as an example here; there is no need for additional examples as there may then be on end to the additional examples provided. Also note that non-biogenic MSW is addressed in Ch 10, not Chapter 7.
26939	7	19	26			When it says 'e.g. Biomass' it should include 'and Municipal Solid Waste'.	Rejected - biomass is provided only as an example here; there is no need for additional examples as there may then be on end to the additional examples provided. Also note that non-biogenic MSW is addressed in Ch 10, not Chapter 7.
20543	7	19	27	19	28	Renewable energy technologies do need metals, including some rare earths. But so do fossil and nuclear sources. In a sustainble future, there will in any case need to be much greater emphasis on recycling and reuse of materials. This is already being practiced to a considerable extent by e.g. the European Photovoltaics industry, recycling PV panels in accordance with the WEE Directive. Could add reference to Spiers at al (2012)"Energy Materials Availability Handbook' UK Energy Research Centre.	Accepted - we have not added this specific citation, as it is grey literature, but the general points have been incorporated in the revised text by de-emphasizing the metals issue.
19878	7	19	28		29	Which materials does renewable energy require that are different from materials for non-renewables. Solar PV needs silicon which is abundant. Electric generators are pretty generic.	Accepted - materials demands are de-emphasized in revised text.
23276	7	19	32			Maybe IPCC 2011a better here than the SPM (IPCC, 2011b)	Accepted
25936	7	19	6	19	6	(Nevertheless, RE potentials should not always considered only as a function of technologies, discarding the social, environmental and territorial usefulness –and then, the RE value- derived therefrom.)	Rejected - We're not certain what specifically is desired by this comment, but we believe that these issues are addressed in the final paragraph of this section.
21125	7	19	9	19	9	Is the operability of energy systems taken into account when analysing potential for RE? E.g. There is a technical limit to the ammount of intermittent generation in a given electricity system due to balancing requirements	Taken into account - the answer is "no", as we believe is relatively clear in the text and also based on a general understanding of technical potential estimates for other resources (e.g., oil tech potential is not limited by total demand for oil, nuclear is not limited by integration concerns and lack of flexible generation).

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20718	7	19	11	19	32	This section should also include a discussion of the varying power densities (e.g. after Vaclav Smil); EROIs (e.g. after Charles Hall, Dave Murphy, et al.); and 'useful energy' after Bob Ayres (and even Frederick Soddy).	Rejected - Though some of these issues are important, and some are indeed mentioned already in passing here and in other sections of chapter 7, space constraints simply do not allow for their assessment in this text.
31647	7	20		21		Whilst the first part of the question is answered (lines 38 to 42) the second part is not answered directly. A succinct summary of potenital should be given and other information removed to save space.	Taken into account - the second part of the question has been deleted.
33870	7	20				In Figure 7.7, geothermal energy has been split into two types and the numbers are very low. According to a MIT report dated to 2008, in the United States at <10 km the heat content is 280,000 EJ at a 25 recovery rate. Therefore, the global numbers are greatly underestimated.	Rejected - we are relying upon the SRREN geothermal chapter for these estimates, which are technical (not theoretical) resource figures. That chapter assessed the relevant literature at the time to develop these figures: more detail available in the SRREN.
20719	7	20	1	20	23	Thorium should be given a mention.	Accepted: A brief discussion on thorium has been included.
23277	7	20	1	20	23	No mention of thorium?	Accepted: A brief discussion on thorium has been included.
19879	7	20	11		12	If 6.3 MtU corresponds to 3700 EJ, then 65000 t corresponds to 38 EJ whereas Table 7.1 says 9.95 EJ	Accepted: The values as previously written make use of the primary energy accounting process (not direct equivalent), further they were for natural uranium (not U metal). The numbers have been adjusted to account for use of metal U.
34184	7	20	15			The sentence in this line needs to be rewirtten because it might suggest that existing reactor could run for another 90 years.	Accepted: Sentence has been rewritten.
26097	7	20	15	27	9	your two estimates of uranium resources (90 years and over 100 years) seem less consistent than would be ideal. They may be subtly different numbers correctly reported, but the impression is bad…	Accepted: the numbers have been altered to accurately reflect the consumption of U metal (not U natural).
21126	7	20	15	20	21	Rate of growth of new reactors?	Rejected: This section is about resources not transformation.
36774	7	20	17	20	17	"doubles the reach of each category". What categories? Resources and occurrences? U and Pu? This discussion would benefit from more definition.	Taken into account: Section 7.4 has been redrafted and this comment has been taken into account during the redrafting.
34185	7	20	18			The potential of fast breeder technology must be confronted with experience of this technology. The notion of potentials and opportunities always requires to balance them with risks.	Noted
20477	7	20	18			insert "theoretically"	Accepted
23599	7	20	20	20	20	Replace "viable" by "competitive". It could be implemented for solving disposal problems at a viable cost	Accepted

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
40688	7	20	20	20	21	"However, reprocessing of spent fuel and recycling is not economically viable below uranium prices of 1000$/kgU(M Bunn et.al., 2003)"should be replaced with "However, reprocessing of spent fuel and recycling is not economically efficient below the present level of uranium prices." or this part should be deleted. Because "not viable" is false based on the fact that some countries are now engaging in reprocessing. Also, it is difficult to refer to the specific level of uranium prices where reprocessing is economically viable, because these countries are engaging in reprocessing in different conditions and reasons such as energy security.	Rejetced: see response to comment 568 above.
32790	7	20	25	20	26	What about the other demand side reduction as the other option in the Kaya identity to reduce GHG emissions?	Taken into account - the comment is obsolete as the underlying text has been deleted.
21796	7	20	25			Kaya identity leads to commensuration of population, income etc. Delete first sentence of this paragraph.	Taken into account - the comment is obsolete as the underlying text has been deleted.
21795	7	20	25	20	34	A more general comment about the mitigation options which it is helpful to draw out is between capital stock substitution (switching) and capital stock expansion, which broadly characterise developed and developing country mitigation challenges respectively. In other words, are these mitigation options needed for new growth, or to substitute / supplant existing stock?	Rejected - the short text on page 20 which covers 10 lines only serves as a preamble for the detailed discussions of mitigation technologies coming afterwards. Investment issues and developing countries issues are discussed in detail in other parts of chapter 7.
21110	7	20	25	21	12	A more balanced presentation should be made : the focus is too much on GHG intensity of energy unit and not enough on other aspects, like possible reductions of energy demand. A way of linking these aspects, would be to have numbers presented in this way : « if global energy consumption is …, then the stabilization scenario requires a mean carbon content of energy unit to be no more than... ». Several set of values should be given (high, medium and low energy consumption).	Rejected - energy demand reductions have to take place in the end-use sectors. The list refers to the options in the energy supply sector. Energy efficiency improvements in the field of energy conversion are included. The interplay between energy demand and energy supply is investigated in detail in chapter 6. A sentence on the importance of demand side measure however now is included.
21127	7	20	25	20	25	Kaya identity? Add reference	Taken into account - the comment is obsolete as the underlying text has been deleted.
32791	7	20	27	20	30	The point of “without direct GHG emissions” is important. GHG emissions still arise, but it is important to realize that we shift them in time and space by using energy from renewable or nuclear resources. Full life GHG accounting is important here to ensure that the proposed alternative accomplishes actually a reduction in GHG.	Accepted - Life cycle emissions now are emphasized.
21797	7	20	31	20	32	This is not a sentence.	Accepted - text revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
27764	7	20	37	20	41	In the corresponding part of the SPM (SPM 4.2.1, pp. 16-17), the mitigation options are listed in the order: natura gas - CCS - Nuclear - Renewable Energy. Policy-makers will most probably associate the order of technologies with their relevance regarding mitigation potentials. Looking at the situation that renewables accounted for nearly half of the estimated 208GW of new electric capacity installed in 2011, it appears inappropriate that renewable energies come last. I suggest changing the order, based on the investments in 2011 or 2008-2011 of the different options. As a minimum it should be indicated – as done in the respective chapter 7 (p.20, lines 37-41) – that the mitigation options are listed “in no particular order”.	Taken - into account. The order here and in the ES now follows the ordering in the chapter.
20847	7	20	38	20	42	Introducing BAT technologies of coal power and transferring it to developing countries are very effective in order to reduce GHG emission. It should be regarded as mitigation options.	Rejected - space constraints do not allow to go into the details of every mitigation option. Increasing efficiency is an option which is already cited.
30913	7	20	38	20	42	This first sentence is long and difficult to follow. It could benefit from revision or reformatting the list structure. Secondly, with the second mitigation option--fuel switching from coal to oil to gas--it is unclear if this is a step-wise process where coal to oil will result in some reduction of GHG emissions but moving from oil to gas is even better. Clarity is required here.	Accepted - text is reformatted.
21798	7	20	38	20	42	Order options by magnitude of potential mitigation.	Rejected - the ordering follows the ordering in the chapter. It is emphazised that the order does not reflect importance.
36775	7	20	38	20	38	"energy sector" should be "energy supply sector". Assuming the authors do not mean the entire energy sector here.	Accepted - text revised.
36776	7	20	38	20	40	Not captured in the term "energy efficiency" is the GHG mitigation potential from methane recovery and use in fuel (coal and gas) extraction.	Accepted - text revised. Reduction of fugitive emissions now is mentioned.
27053	7	20	4			It is unlcear how "fuel switching from coal to oil to gas" is supposed to be interpreted as a GHG mitigation option. I would assume that it means that switching from either of the three technologies to technologies with lower CO2 emissions, would mitigate CO2 (since they are all carbon based. However, as it stands, it can be read as meaning that a switch from coal to oil is a mitigation option (which it is not) and that a switch from oil to gas is an option. Please clarify that the sentence means a switch from any of the three technologies is a mitigation option (if that is what is meant). If it means that swithcing from oil or coal to gas (which should not be the interpretation in my opinion), then switching to renewables and nuclear should be included as well and it should be noted that the latter two has a higher mitigation effect per unit of energy, due to their much lower carbon content than gas.	Accepted - the meaning of fuel switching now is clarified. The wording from coal to oil to gas is avoided.
21799	7	20	40			Fuel switching is from coal to oil or gas, and from oil to gas. Current expression implies coal is switched to oil and oil is switched to gas. Fuel switching should also be stipulated as being fossil fuel switching (as biomass / biofuels are excluded).	Accepted - the meaning of fuel switching now is clarified. The wording from coal to oil to gas is avoided.
21128	7	20	40	20	40	Review wording: 'switching from coal to oil to gas'	Accepted - the meaning of fuel switching now is clarified. The wording from coal to oil to gas is avoided.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36777	7	20	40	20	40	In this list of GHG mitigation options, fuel switching among fossil fuels is listed, but not switching to electricity (also known as electrification), which constitutes an important GHG reduction strategy across transportation, buildings & industrial end-uses (but maybe falls outside the Chapter 7 domain). It is mentioned on p. 23, lines 30-31 suggesting that this should be included in this list.	Accepted - electrification now is mentioned.
25706	7	20	41	20	42	The part of "which, when combined with bioenergy, can result in negative emissions (BECCS)" should be deleted completely because it is uncertain whether BECCS can be utilized in the future, as described in the section TS.3.3 (page 21, line 37). Safety confirmation, affordability and public acceptance are indispensable in CCS site selection. There is a much higher barrier to adopt BECCS than CCS because BECCS requires stable biomass supply for generation at reasonable cost. Since feasibility for BECCS has not been established so far, it is not appropriate to expect huge potential for BECCS in the future, as described in (Rhodes, 2008, page323). This literature is listed in the No7 line of this table.	Accepted - BECCS = biomass + CCS is not singled out now, because space constraints do not allow for a detailed discussion. However biomass (as part of RE) and CCS options are part of the list.
21104	7	20	42	20	42	The IEA WEO 2011 (p. 235) states about biomass generation with CCS : « this technology is not proven at a commercial scale, and therefore cannot be counted upon ». The large uncertainty concerning BECCS should be reflected.	Accepted - BECCS = biomass + CCS is not singled out now, because space constraints do not allow for a detailed discussion. However biomass (as part of RE) and CCS options are part of the list.
30074	7	20	42			(which, when combined with bioenergy , can result in negative emissions (BECCS).) So it is not garanted that the CO2 will be captuered for ever this is not true in absolutely terms.	Taken into account - BECCS has been deleted as space constraints do not allow for a detailed discussion of its merits and shortcomings in a FAQ format.
30914	7	20	43	20	43	The use of slang here (e.g., silver bullet) could be better written using language that is understood well by all readers and will also translate well.	Accepted - text changed.
26177	7	20	43	20	44	Please change mean temperature to 2100 tempature acoording to table 6.1.	Rejected - the Cancun Agreement refers to 2°C (compared to the pre-industrial level).
25707	7	20	43	20	45	This part should explain unlimited evaluation results because it is prejudicial and misleading to put an emphasis on limited scenarios of 2℃. IPCC should be policy-neutral and should have responsibility to indicate unlimited evaluation results, as described in Table 6.1. The 2℃ target is extremely difficult to attain, as described in (Höhne, 2011, conclusion) and (Rogelj, 2011, abstract). These literatures are listed in the No4 line of this table.	Rejected - the Cancun Agreement refers to 2°C (compared to the pre-industrial level). The agreement belongs to the UNFCCC decision making process and the IPCC has been established in order to inform exactly this process. IPCC reports must be policy relevant; investigating one scenario that has a relevance for the UNFCCC in detail does not mean that the IPCC does endorse it. The sentence therefore is neutral and neither prescriptive nor normative.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
27765	7	20	46	20	46	What is meant by "energy efficiency" in this respect? If it is only energy efficiency in transmission and distribution, then clearly the option to reduce energy demand through efficiency and behavioral change is missing as an option. If the latter is included, then I do not see how this conclusion was drawn. An analysis of scenarios with strong energy efficiency and far-reaching behavioral change is nowhere to be found. I suggest changing the sentence as follows: "Significant emission reductions can be achieved by supply-side energy efficiency improvements and fuel switching within the set of fossil fuels, but - considering expected trends in energy demand - their combined effect is not sufficient to provide the deep cuts needed to achieve the Cancun target."	Rejected - energy demand reductions have to take place in the end-use sectors. The list refers to the options in the energy supply sector. Energy efficiency improvements in the field of energy conversion are included. The interplay between energy demand and energy supply is investigated in detail in chapter 6. A sentence on the importance of demand side measure however now is included.
36773	7	20	7	20	7	Should be more specific and say "R&D efforts to develop vastly improved and less expensive extraction technologies" (for U from seawater)	Accepted.
19880	7	20				I suggest including thorium in this section. Although it is mentioned briefly in 7.5.4, it should be included in 7.4.3 since thorium is more abundant than uranium from a resource perspective.	Accepted: A brief discussion on thorium has been included.
24635	7	20	1	20	23	Completeness - there is no discussion of thorium research or its capacity/viability as a potential energy source. Dismissing the technology is fine, but there needs to be a sentence indicating that it is beyond the scope of AR5 and a brief explanation of why - presumably in page 71, lines 5-31, section 7.13.	Accepted: A brief discussion on thorium has been included.
25509	7	20				Concerning the shorten of the whole chapter by 10 pages, the section 7.5” Mitigation technology options, practices and behavioural aspects” can be noted one possibility because the sub sections’ analyses can be summarized further rather than details though content is important. Furthermore, the ordering of the subsection can be re considered. For example, 7.5.2 Energy efficiency in transmission and distribution (can be shorten this subsection) would be shifted to after the 7.5.4 which has rational combination with the section 7.5.5.	Accepted - the text now is more focused. Scenario and storage size discussions in the field of CCS now have been moved out of 7.5. In addition, the focus now lies on what progress has been seen since AR4. The order of the section, however, has not changed.
23291	7	20	24	31	7	As covering what's new since AR4, then much of th detail in this whole section can be shortened.	Accepted - the text now is more focused. Scenario and storage size discussions in the field of CCS now have been moved out of 7.5. In addition, the focus now lies on what progress has been seen since AR4.
24292	7	20	25	20	34	It is suggested to provide a cleared description about the relationship between the KAYA Identity and mitigation technologies.	Taken into account - the comment is obsolete as the underlying text has been deleted.
31531	7	20	25	20	34	It is suggested to provide a cleared description about the relationship between the KAYA Identity and mitigation technologies.	Taken into account - the comment is obsolete as the underlying text has been deleted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
27763	7	20	24	31	7	The order of listing of mitigation options in the energy sector is somewhat misleading: One may read NGCC as the most important technology. However, NGCC is by far not emission free as it is the case with renewable energies or nuclear (see e.g. fig 7.9 in WG III AR5). The same applies for CCS. In Chap 7.8.1 AR 5 it is stated that "..., average emissions from power generation need to be reduced to below 100 gCO2e per kWh by 2050 to meet a 2°C mitigation goal (IEA, 2010b) and would eventually need to go to or below zero (chapter 6 and 7.11), so that the employment of technologies with even lower emissions is called for if these goals are to be achieved." In this regard, NGCC and CCS can hardly be seen as an appropriate mitigation technology as they feature specific emissions beyond 100g per kWh. At least, the ordering of technologies should reflect the specific mitigation potential e.g. nuclear and renewable comes first.	Rejected - the order of mitigation options reflects is based on a consideration what can be done in the short term and what needs more time. Energy improvements, and fuel switching as well as RE are ready to be applied immediately. Nuclear construction times are long and CCS is a still a prospective technology.
25173	7	21				Recommend rewrite to exclude assumption of mitigation. (lines 23-25) Otherwise, citation of offset required here. See comment on Chapter 7 entitled: **Implicit assumption of renewable energy mitigation potential are not supported by recent empirical, behavioral, and macroeconomic analyses	Rejected - the comment seems to be misplaced. Line 23 - 25 are not part of the FAQ 7.2. The comment on implicit assumptions is treated where it is raised.
21129	7	21	1	21	3	Mention demand side response	Rejected - energy demand reductions have to take place in the end-use sectors. The list refers to the options in the energy supply sector. Energy efficiency improvements in the field of energy conversion are included. The interplay between energy demand and energy supply is investigated in detail in chapter 6. A sentence on the importance of demand side measure however now is included.
21895	7	21	13	21	27	Even with the extra fugitive emissions accounted for gas remains far less carbon intensive than coal.	Taken into account. This is exactly what we say.
36778	7	21	13	22	9	When discussing options for mitigating global CO2 emissions suggest the authors provide an indication of maximum reduction potential based on a suite of options (e.g., NGCC, Oxy + CCS, IGCC + CCS, NGCC + CCS)? As written, there is a disproportionate emphasis on NGCC.	Editorial. Please note that the CCS issue is treated in section 7.5.5.
26078	7	21	14	21	27	It need to be mentioned that a shift to new conventional gas fired power plants will lead to a fixed level of emissions for a lifetime of about 35 years of the power plants. The average reader will not realize that the power plants have a very long life time for which the emissions will then be fixed.	Taken into account - lock in effects are discussed in 7.10.5.
25708	7	21	14	21	25	This part should be revised to explain that it is important to use coal power efficiently from a viewpoint of energy security and economic efficiency. IGCC (Integrated Gasification Combined Cycle) technology is developing and has potential to reduce CO2 emission in the future, as described in (IEA, 2011, page7, page42 Fig14) and (Janos, 2009, page5, page7 Figure1 and Table 1). These literatures are listed in the No10 line of this table.	Taken into account. We see this issue as adequately addressed: the potential efficiency gain is indicated in Fig. 7.6.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
31648	7	21	14	21	14	A causal link is implied between the opening phrase "Given the importance of heat and power production in the energy sector," and the rest of the rest of the opening sentence. This is not correct as the importance of the production of heat and power in the sector does not affect the options for fuel and technology switching in the way described. If the intention was for this sentance to focus on the potential benefits from the use of CHP the sentance needs to be restructured to do this. However, it does not appear an appropriate opening to the section given the section title. An opening sentance that outlines the relationship between the three topics in the heading would be a better introduction. The topics could then be dealt with in order.	Accepted. Text has been changed.
32461	7	21	14	21	17	It should include the view that effective utilization of coal fired power plant is needed for energy security.	Rejected. Energy security is not addressed in this paragraph; the energy senarios investigated in 7.11 indicate that energy supply can be secured with a lower share of coal than today.
21130	7	21	15	21	15	Is NGCC equivalent to CCGT or are these two different types of generators?	Noted.Good point CCGT used in 7.8. Should be replaced by NGCC.
21131	7	21	15	21	15	What about biomass?	Taken into account - biomass is treated in 7.5.3 and the bioenergy annex of chapter 11.
35390	7	21	16			After CHP plants, add 'excluding MSW incinerators'. Reasons: for CHP incinerators of MSW, energy conservation is lower than upstream strategies to manage waste, so these should not be favoured as a preferable GHG mitigation strategy over ppstream strategies,which in contrast, keep wastes that cannot be recycled or composted from being generated in the first place and thereby offer much larger potential for GHG abatement through the reduction of emissions associated with raw material acquisition, manufacturing, and transportation. These approaches include options related to waste reduction, reutilisation, and recycling. References: US EPA, Solid Waste Management and Greenhouse Gases: A Lifecycle Assessment of Emissions and Sink. 3rd Edition, 2006; Morris, J., “Recycling versus incineration: an energy conservation analysis”, Journal of Hazardous Materials 47 (1996), 277-293; D. Hogg, A Changing Climate for Energy from Waste? Eunomia Research & Consulting for Friends of the Earth, 2006; Tellus Institute, Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan, Review submitted to the Massachusetts Department of Environmental Protection, 2008.	Noted. Text has been modified.
35443	7	21	16			After CHP plants, add 'excluding MSW incinerators'. Reasons: for CHP incinerators of MSW, energy conservation is lower than upstream strategies to manage waste, so these should not be favoured as a preferable GHG mitigation strategy over ppstream strategies,which in contrast, keep wastes that cannot be recycled or composted from being generated in the first place and thereby offer much larger potential for GHG abatement through the reduction of emissions associated with raw material acquisition, manufacturing, and transportation. These approaches include options related to waste reduction, reutilisation, and recycling. References: US EPA, Solid Waste Management and Greenhouse Gases: A Lifecycle Assessment of Emissions and Sink. 3rd Edition, 2006; Morris, J., “Recycling versus incineration: an energy conservation analysis”, Journal of Hazardous Materials 47 (1996), 277-293; D. Hogg, A Changing Climate for Energy from Waste? Eunomia Research & Consulting for Friends of the Earth, 2006; Tellus Institute, Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan, Review submitted to the Massachusetts Department of Environmental Protection, 2008.	Rejected. We did not find space to address MSW here.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26951	7	21	16			After CHP plants, add 'excluding MSW incinerators'. Reasons: for CHP incinerators of MSW, energy conservation is lower than upstream strategies to manage waste, so these should not be favoured as a preferable GHG mitigation strategy over ppstream strategies,which in contrast, keep wastes that cannot be recycled or composted from being generated in the first place and thereby offer much larger potential for GHG abatement through the reduction of emissions associated with raw material acquisition, manufacturing, and transportation. These approaches include options related to waste reduction, reutilisation, and recycling. References: US EPA, Solid Waste Management and Greenhouse Gases: A Lifecycle Assessment of Emissions and Sink. 3rd Edition, 2006; Morris, J., “Recycling versus incineration: an energy conservation analysis”, Journal of Hazardous Materials 47 (1996), 277-293; D. Hogg, A Changing Climate for Energy from Waste? Eunomia Research & Consulting for Friends of the Earth, 2006; Tellus Institute, Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan, Review submitted to the Massachusetts Department of Environmental Protection, 2008.	Rejected. We did not find space to address MSW here.
21802	7	21	17			Fuel cells (and the H2 synthesis and distribution) are barely mentioned in the chapter which, as noted above, is strongly weighted towards available substitutes for conventional electricity generation. Fuel cells as a conversion technology, and H2 as a potential energy carrier, warrant specific attention.	Noted. Text has been modified.
20455	7	21	17	21	18	Consider re-writing this sentence to not be so pessimistic regarding emissions from shale gas extraction. It is not clear why you state that shale gas emissions are "probably" higher than previous estimates, particularly given that recent studies (e.g. O'Sullivan and Paltsev) seem to show that EPA estimates actually tent to be too high.	Taken into account.
36779	7	21	17	21	19	This topic could benefit from a more balanced perspective, with references covering alternative views. As a counter-balance to Petron and Wigley, consider also two EPA studies (emissions projections reports) and EIA analysis. Consider including discussion of technologies that capture fugitive CH4 emissions.	Rejected. Imprecise reference. A search for "methane emissions projections" on the EPAs website did not yield any recent publications that would contradict the ones cited here. Please note that we see this as a balanced statement, as we treat these emissions as an open issue.
21800	7	21	2	21	3	Much more intensive use of low C supply technologies has to be in the context of aggressive demand reduction efforts.	Taken into account - demand side options now are mentioned as well before the bullet list.
36780	7	21	20	21	23	Does the estimate for "fugitive methane emissions" include coal mine methane (CMM) or only shale and conventional gas extraction? Burnham et al. does include an EF for CMM but it is unclear whether it was included in the analysis.	Noted. Yes, it does. We have implemented the emission factors from Burnham also for coal, as indicated in the text.
26794	7	21	21	21	21	Small k for kWh	Noted.
23278	7	21	21			kWh	Accepted.
36781	7	21	21	21	21	It would be helpful to present a range here. Life cycle estimates vary greatly. Please explain how the 50% value was selected?.	Taken into account. Please note that the range was taken from the Corsten et al. Reference provided, while the bars reflect new calculations using the best estimate of fugitive emissions from Burnham et al, as stated.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36782	7	21	23	21	25	What is the basis for making this comparison with only subbituminous coal? Is the current "world-average" coal similar to subbituminous? If the comparison is due to the fact that the cited study compared only to subbituminous coal, that should be noted here.	Editorial. Any type of coal would suffice to make the point, but subbituminous coal is frequently used in power plants.
19639	7	21	24	21	24	Spelling: sub-bituminous (not 'bitumenous')	Noted.
20848	7	21	25	21	27	We can reduce large amounts of GHG emission by popularizing the best available technology of coal power. Effectiveness of it should be noticed.	Taken into account. Please note the figure shows the emission reductions attainable for going from the average to a supercritical coal fired power plant or an IGCC.
29178	7	21	29	22	3	The figure is based on (Singh et al., 2011), with updated numbers for fugitive emissions (Burnham et al., 2012) and uncertainty bars based on lower estimates for fugitive emissions (Corsten et al., 2013). Although all three papers are peer reviewed, they are all recent publications so it would be good for the caption to also describe what agreement was reached on the robustness of the evidence and what risk there is that this evidence will be revised after further consideration.	Accepted
30075	7	21	3			(and CCS) elimination	Note - it is not clear what the reviewer means with "(and CCS) elimination".
36784	7	21	33			This depiction of gas fuel chain emissions needs stronger justification - suggest adding addtional references to substantiate numbers that otherwise look generally high.	Accepted. It has been implemented.
36785	7	21	33			Need to disclose the choice of timescale for GWPs used here, as timescale is hugely impactful.	Editorial.
36783	7	21	33	21	33	Although Burnham et al. is cited, it is unclear in the text whether coal mine methane emissions are included in the analysis.	Editorial. Yes they are, as stated.
21801	7	21	4	21	9	These two paragraphs are very vague and can be deleted.	Rejected - a high level discussion always suffers from space that would be needed to go into the details. The mentioned points are important ones. They are now linked to the underlying text, where more details can be found.
24636	7	21				This graph is difficult to read and understand. Suggestions: Increasing its size, Indicating what the horizontal line above 1,0 is meant to indicate (assumption that it is BAT?), Labelling/providing a range for all (rather than some) reductions are labelled or have a range, and Specifying whether emission intensity comparison relates to gas from conventional, rather than unconventional, sources	Accepted. The figure was incorrectly reproduced in the draft and has been fixed.
31649	7	21		21		It is not clear what are the key messages of this section. Resequencing the information in this section to deal with extraction, conversion and switching aspects in that order would mean that some of the current repetition such as in relation to fugitive emissions from gas production could be avoided and some space saved.	Noted.
24135	7	21	17	21	19	The statements could be re-worded to simply state that fugitive methane emissions for both shale gas and conventional gas are uncertain. Is there confirmation that these are higher or lower than assumed?	Rejected. There is confirmation that they are higher than previously assumed in the literature cited.
23911	7	21	18	21	19	It is better to explain the reason for this uncertainty, since time doesn't allow one to check the content of the citations.	Noted.
23912	7	21	21	21	21	There is certainty expressed in the 5-% reduction, while the the previous two lines express uncertainty and probabilities associated with fugitive emissions. This statement should retain consistency.	Accepted. Language changed.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26045	7	21	22	21	24	This sentence needs to be recaste as it lacks clarity	Rejected. The reference is misspecified - the page does not contain the section indicated.
20456	7	22	12	22	15	Can you clarify why you believe energy emissions will increase in the future, particularly given that the LCA by Burnham et al (2012) suggests that life cycle emissions from unconventional gas is actually lower than than from conventional gas.	Editorial. Please note that four reasons are provided for the statement. The statement is supported by two references.
26079	7	22	15	22	15	The correct name of the author is 'Lechtenboemer' not 'Leuchtenboemer', please correct here and in the literature list.	Noted
31650	7	22	16	22	16	The implications of the phrase "higher energy efficiency" are not clear in this context.	Noted
26781	7	22	21	22	29	As a biproduct of oil sands processing, there is a significant level of Petroleum Coke produced, which is burnt in coal fired power stations, with a higher level of kg/kWh than traditional coal. Lorne Stockman, "Petroleum Coke: the coal hiding in the tar Sands", Oil Change International, 2013. I do not think this is a peer reviewed report, but the issues highlighted should be commented on if found appropriate. As it seems to have disappeared from the original website I will forward a copy to the main email address for this review.	Taken into account. Please note that this issue is not substantial enough to be discussed in such a concise text.
24638	7	22	21	22	23	For industries such as coal mining, the pursuit of means to understand, measure and capture fugitive emissions is of real importance in the context of a carbon tax, for example. Suggest rephrasing to make the significance of this point more clear	Accepted. Text revised.
31651	7	22	21	22	23	The meaning of this sentence is not clear. In what sense is the discussion controversial? Is this supposed to mean that the discussion disagreed about this topic? In what sense variable and uncertain?	Noted. more space needed.
36790	7	22	21	22	23	The authors should more firmly articulate their position regarding the controversial nature of the conclusions of Howarth et al. Subsequent literature certainly seems to identify their analysis as flawed.	Noted. Text has been modified.
36789	7	22	21	22	29	This is somewhat repetitious from the previous page. Consider eliminating or reducing.	Accepted. Text has been modified.
36792	7	22	23	22	24	It would be helpful here to lay out the broader oil and natural gas emissions sources (e.g., natural gas transmission, processing) and mitigation options to capture or reduce these emissions.	Noted. Text has been modified.
36791	7	22	23	22	25	This discussion should be expanded to recognize that teh amount of emissions depends significantly on not just extraction practices such as green completions, but on the age, proper construction, and maintenance of the natural gas infrastructure being used to collect, transport, and process the gas.	Noted. Text has been modified.
21804	7	22	24			Explain green completion.	Noted. more space needed. References are provided.
24138	7	22	25	22	29	The emissions associated with synthetic crude production from oil sands differ based on whether integrated upgrading or stand-alone upgrading is practised. Integrated upgrading has lower emissions due to energy integration. Please modify the statement to reflect this.	Noted. Text has been modified.
20457	7	22	25	22	29	Provide actual numbers (and their range) for the emissions from oil sand production. Also, clarify whether these emissions are from integrated operations or are stand-alone. It may be appropriate to include more recent publications from Bergerson et al (2012) and Charpentier (2011), along with the range of emissions estimates they provide.	Noted. Text has been modified.
21897	7	22	30	22	40	Electricity transmission's impact on emissions is not limited just on reducing losses (which are handled reasonably well in most EU countries). There's a lot more scope in facilitating power transfer from new renewable energy installations towards consumption centres.	Taken into account - This is dealt with in 7.6.1.
19061	7	22	30	23	19	These paragraphs could be shortend	Accepted.
32792	7	22	31	22	33	References needed. Also, the higher voltage used in transmission lines implies lower resistive losses.	Agreed - text has been amended. And refs added.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26907	7	22	31	22	33	There is also the relationship between voltage and losses that explains why losses are greater in distribution systems.	Agreed - text has been amended. And refs added.
24401	7	22	31	22	33	"Electrical losses associated with the high voltage transmission system are generally less than losses within the lower voltage distribution system mainly due to the fact that the total length of transmission lines is far less than that for distribution in most power systems." I'm not certain how accurate this statement is. Although the distance makes a difference, higher voltage lines carry less current and, by Joule's Law, power loss goes as current squared, so a small drop in current leads to a large drop in power loss. Power is conveyed at high voltage to minize Joule heating losses.	Agreed - text has been amended. And refs added.
36793	7	22	31	22	37	The assertion that HV losses are lower than LV losses needs to be cited. It is non-intuitive to those of us who live in the US, where power travels long distances over HV lines. Even though there are more miles of LV lines, there might be roughly equvalent kWh-miles traveled given the heavily loaded nature of HV lines. This is not disagreement with the assertion -but rather a request to cite supporting literature.	Agreed - text has been amended. And refs added.
21896	7	22	4	22	9	LNG (when liquified with coal-based energy) and transported over long distances it's GHG impact can be close to the one from coal.	Noted. Unfortunately there is no space to consider LNG transport in detail. Liquefaction is mentioned as a source of emissions.
36786	7	22	4	22	5	Suggest that this sentence be qualified with the word "indefinitely".	Noted. Text has been modified.
19768	7	22	41	23	4	A number of statements in this paragraph need justification and backing up by relevant references. Refering to the European Copper Institute from 1999 is really not up to data enough. Perhaps ENTSO-E (formerly UTCE) could provide more details.	Noted. ENTSO-E don't publish data on losses.
24639	7	22	41	23	4	Paragraphs are location specific (i.e. Europe) rather than addressing global differences in energy efficiency in transmission and distribution. Suggest that these should be deleted.	Noted.Since data was hard to find those presented are for specific regions. No reason to believe that other regions will be very different.
33884	7	22	41	22	41	Does 40% of distribution losses refer to a global average? This is unclear.	Noted.It's an EU average.
19060	7	22	41	22	49	If small-scale biomass generating stations are promoted serving local communitiies, this should reduce distribution losses, increase the store of organic C in wood and soils and provide rural jobs.	Noted. This issue is dealt with in 7.6
36794	7	22	41	22	45	You might consider adding a reference on the recently-passed U.S. standard on distribution transformers. See http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/66	Noted.
32793	7	22	44	22	45	What are the cost estimates for more efficient transformers? A note on their lifetime would help put the lag to replacement into perspective.	To achieve low in service failure rates the MTBF is generally in 100s of years.
21805	7	22	44			Give ballpark estimate of $ cost (e.g., per grid, per country, per transformer).	Taken into account - comment is obsolete as the underlying text has been deleted.
33868	7	22	44	22	44	This report should be cost netural and avoid statements such as, "although the investment required to do this should not be underestimated." Instead, the focus should be on technologial advancement (e.g., reducing GHG without the concern of cost).	Noted.
36787	7	22	5	22	5	Suggest rewording this sentence to explicitly explain: the significance of (i) extent and (ii) time scale of NGCC use for "base-load power production" that NGCC (i) cannot, at any time, account for all base-load generation, and (ii) to whatever extent, should deploy as a "bridge" or "transition" fuel, between (current) coal-dominated and (ultimate) low-carbon states of power supply.	Noted. The issue of transition is addressed in section 7.11. There is not sufficient space to go into detail.
21803	7	22	6	22	7	Clarify this sentence: is a downward adjustment of the estimated benefit because of higher than previously understodod emissions (relating to earlier point about fugitive methane).	Noted. Text reworded.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36788	7	22	6	22	7	"A better appreciation of the importance of fuel chains since AR4 results in a downward adjustment of the estimated benefit from fuels switching": "Fuel chain" issues, particularly fugitive emissions, need a more nuanced and in-depth discussion, to reflect a range of assessments. Different studies agree that fugitive emissions may impact life cycle outcomes, but diverge as to the exact magnitude and sign of attributable effects. Please reflect that fugitive emissions may be a real factor of potentially variable influence, e.g., as a function of situationally specific interplay with technology (e.g., capture) and/or policy measures.	Noted. Text reworded, within space constraints.
23914	7	22	10	22	12	Having looked at the basis of these estimates, it appears that they are generated from emission factors from the US EPA. What is missing in all of these figures are measured values from commercial scale gas plants. Tight environmental regulations in the Middle East and elsewhere have stringent requirements to be met on fugitive emissions and to ensure compliance VOC detectors are installed around the plants. IEA is liberally cited throughout this chapter, but one must ask what level of auditory supervision is applied to its output.	Rejected. No references or new information provided.
23915	7	22	15	22	20	These lines could easily be deleted as they convey little information due to generalisations and what, for example, is meant by fuel production - what sort of fuel? Methane from coal mining is surely unconventional??	Editorial
23916	7	22	28	22	28	Reading MR Johnson and Coderre, 2011, it is incomprehensible that local authorities allow such flagrant use of flares and venting. Flares are not incinerators and should never be used as such. Look to California and Texas and see the level of control on refining and petrochemical industries by local commissions- where every incident of flaring has to be reported and explained. On a visit to ChevronTexaco refinery in California where flaring is severly restricted, no flaring was evident during my visit. Perhaps this report should have a stronger emphasis on local authorities and regulators to reduce the emissions from bad and irresponsible practices by the oil/gas production companies. Alberta ERCB reports that solutions gas flaring has reduced by 71% since 1996 and venting down 54% since 2000.	Taken into consideration. The information stated here is broadly in line with our text.
24637	7	22	7	22	9	The statement citing Jaramillo et al (2007) appears to conclude that the worst-case scenario for LNG lifecycle emissions occur when, among other things, the liquefaction process utilises coal power. Jaramillo et al notes that emission factors for liquefaction were calculated using the AP42 emission factors for reciprocating engines and natural gas turbines; a statement that seems at odds with this conclusion. Suggest reviewing the reference/contacting authors to confirm that it has been accurately cited	Accepted. Text has been changed.
23913	7	22	7	22	9	This statement is irrelevant and should be deleted as it has no application in the bulk of LNG global large scale plants where power supply is generated on the LNG facility itself.	Accepted. Text has been changed.
31652	7	22				Unless the criteria for differentiating between transmission level and distribution level are set out the distinction is not meaningful. There is no single voltage boundary that is globally accepted. The discussion suggests that the differentiation is on the basis of line lengths but this is not a global metric either. Perhaps it would be better to start by stating the loss sources (NOTE: it would be appropriate to include theft as a mechanism which contributes to the apparent level of loss. In India it has been a major loss mechanism though efforts are being made to address this). Then introduce the idea of the split between T and D losses as they are predominantly linked to line lengths which is only one of the sources. This could be followed by the discussion of transformer losses as these largely occur at interfaces between T and D systems and between different voltage elelments of these systems, and between the T and D systems and generators and customers.	Noted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24293	7	22	31	22	33	The difference between the electrical losses associated with the high voltage transmission system and the lower voltage distribution system also due to the loss rate from the voltage. It should be added that "and the lower loss rate from higher voltage" after the statement. (Ruby Abbasi a 2012) Ruby Abbasi a 2012. Reduction of Transmission Line Losses Using VLSI Interconnect. Procedia Engineering. 30. 10-19.	Accepted. to add: the suggested phrase and reference: "and the lower loss rate…..)
31532	7	22	31	22	33	The difference between the electrical losses associated with the high voltage transmission system and the lower voltage distribution system also due to the loss rate from the voltage. It should be added that "and the lower loss rate from higher voltage" after the statement. (Ruby Abbasi a 2012) Ruby Abbasi a 2012. Reduction of Transmission Line Losses Using VLSI Interconnect. Procedia Engineering. 30. 10-19.	Agreed - text has been amended.
29179	7	22	31	22	33	It should be made clear that transmission is at voltages significantly higher than distribution voltages, therefore affecting losses.	Accepted. to add: the suggested phrase and reference: "and the lower loss rate…..).
23917	7	22	37	23	36	This section contains little new information and could be considerably shortened without loss of content.	Taken into account - space reduced by 50%.
25377	7	23	1	23	4	This part should be left in this report, as connecting renewable energy to utility grid would be expected to increase transmission losses.	Noted. Support for retaining the text.
32794	7	23	1	23	4	References needed here. An advantage to more interconnections is resilience in the system, from both an increase in the number of paths for routing energy from source to sink and reducing the the loads on lines.	Accepted. A valid point - in fact the result will be highly application dependent. The phrasing has been adjusted but references are hard to find.
25709	7	23	1	23	4	This part should be kept in the final version report because problems of RE are mentioned well and comprehensively. Transmission losses caused by introducing huge amount of RE are considered to increase more than those of constituted only by large scale power plants system. This is because renewable power generators are located far from city areas, as described in (Quezada, 2006, page 533 and 537) <Reference> [1] V.H. Méndez Quezada, et al (2006). Assessment of Energy Distribution Losses for Increasing Penetration of Distributed Generation, IEEE TRANSACTIONS ON POWER SYSTEMS, VOL. 21, NO. 2, MAY 2006,	Taken into consideration. The given reference was added although this supports the point about DG rather than the impact on transmission losses.
21806	7	23	1	23	4	There are an increasing number of studies on large scale RE integration (not least on the Danish experience) which can be reviewed.	Accepted. Papers identified.
36795	7	23	1	23	4	It would be useful to note that there might also be power quality (phase, voltage, noise) impacts from significant RE penetration.	Noted. These are governed by standards so should not be an issue.
36796	7	23	1	23	4	Note also that new technologies for the bulk transfer of power are coming online, e.g., in China.	Noted. Not new but HVDC.
36797	7	23	13	23	19	This section sounds like it was written perspective of advocacy for GIL. While GIL may be necessary in areas where overhead lines are not permissible, a quick search on GIL shows that they are filled with SF6 gas. This sounds like potentially a very harmful development from the point of net GHG emissions. Suggest the authors reconsider this section for balance.	Taken into account - comment is obsolete as the underlying text has been deleted.
25166	7	23	13	23	14	Gas insulated transmission lines also involve the use and release of exotic greenhouse gasses such as sulfur hexaflouride with a global warming potential over 22,000 times higher than CO2. This should be aknowledged.	Taken into account - comment is obsolete as the underlying text has been deleted.
32795	7	23	16	23	19	Is the sub-sea application for HVDC an example of the application where those cables have lower losses, or a separate point altogether?	Noted - It is so with reactive power requirements of sub sea AC cables.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
31653	7	23	16	23	17	This sentence is confusing and in particular the mention of critical dependance on application in the parenthesis and the mention of 'such applications' in the text without explanation of what is meant by applications in each case. Are they the same applications? If so the sentance should be revised with the repetition removed.	Accepted. Text has been changed.
36798	7	23	20	23	29	The word "extensive" (line 21) seems out of place. It is not clear if the technologies described in this paragraph are new technologies, or simply existing technologies that are only used in cold weather conditions. Compared to other sub-sectors, there does not appear to be much headroom here, and one wonders if it's worth mentioning at all.	Noted.The term energy extensive has been replaced by energy consuming. This paragraph is talking about flow assurance which addresses chemical additives and equipment to assure flow (easyness of flow and consequently lower energy) and thereby reduce required energy. Cold weather represents a problem which can result in high energy required to move the fluids.
31654	7	23	21	23	21	energy extensive process' may not be the correct term in this context.	Noted.The term energy extensive has been replaced by energy consuming. This paragraph is talking about flow assurance which addresses chemical additives and equipment to assure flow (easyness of flow and consequently lower energy) and thereby reduce required energy. Cold weather represents a problem which can result in high energy required to move the fluids.
36799	7	23	24	23	29	Should this section also discuss oil transport with trucks/trains/ships, and not just pipelines?	Rejected - space constraints do not allow to go into all details here.
36800	7	23	24	23	29	It seems this should also include a discussion of natural gas transmission in addition to oil.	Noted. The discussion of flow assurance in line 24 to line 36 is talking generally about fluid (oil and gas) flow in pipes which include natural gas
32796	7	23	30	23	36	This point is often asserted. A defence of this assertion would be useful to support what might be considered “obvious.” Moreover, it is useful to the reader to know if electric vehicles and heat pumps are the only new technologies which will require large upgrades to the power system and over what timeframe.	Noted. A reference to Chapter 8.3.4.2 where this is discussed is added.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
31244	7	23	30	23	34	It is not necessarily the case that shifting space heating and cooling to heat pumps will require a large increase in electricity generation capacity. Rather, if only buildings that have undergone an upgrade in the performance of their thermal envelops are shifted, the accompanying increase in the thermal time constant (due to much smaller rates of heat loss) will mean that heat pumps could be largely operated when intermittent wind energy is available, or can be largely operated during offpeak periods.In fact, if some portion of existing electric resistance heating is also shifted to heat pumps (after thermal envelope upgrades), there could be no net effect on electriciity demand. I have a paper (pending submission) that quantifies this - I'll send a copy to the CLAs later.	Taken into account - text revised.
21808	7	23	30			Decarbonisation of heat through heat pumps depends on the carbon intensity of the grid.	Accepted. Text has been changed.
33005	7	23	30	23	36	Here it would be useful to refer to the sister discussion on Evs in Chapter 8.	Accepted.
31655	7	23	34	23	36	it is not clear in what the "new investments" referred to would be. Is it in heat pumps and EVs, or, in improved T & D infrastructure, or, in DSM systems, or, some combination of these?	Taken into account. Text has been changed.
36801	7	23	36	23	36	"alternative more energy"? Is this "more alternative energy"? Please clarify.	Taken into account. Text has been changed.
20720	7	23	42	25	29	The Special Report was in fact weak on this, especially in relation to wind energy. One of the main authors of the wind chapter failed to mention or cite work which showed his work was fundamentally flawed (see counter-evidence in David MacKay "Sustainable Energy" and Michael Jefferson 'Energy Policy' 2008. There are huge variations in performance according to location and weather conditions year by year in many countries. There are the more general issues of power densities, EROIs, etc.	Rejected - We are not able to discern what specific aspects of the present text are deemed problematic by the reviewer. LCA estimates of carbon benefits from RE (similar, but not the same as, EROI) are addressed later in the chapter and issues related to integration/valuation are addressed later in the chapter as well (comments on those aspects are presumably offered in those sections of the text). No other specific missing aspects or inaccurate aspects of the present text are noted that are actionable by the authors.
21809	7	23	45			I think this is the first mention of energy services which is rather staggering. (See earlier point about energy services driving change in the energy system). If they are deemed importance, mention more clearly upfront. If they are not deemed important, replace here with earlier terms (e.g., final energy, energy end-use).	Noted - this issue is really to be determined by other LAs, in earlier section of AR5. We have retained the language in this sentence as it is the precise way of conveying the idea than fuels can meet multiple needs.
23601	7	23	46	23	46	Add before "Many RE sources are primarily deployed within larger, centralized energy networks" the following caveat " Despite the variability of wind and solar enenrgy,"	Rejected - issues of variability and uncertainty in output are addressed elsewhere in Ch 7, and are not intended to be covered in this section due to space constraints and to minimize overlap with other sections of the chapter.
23279	7	23	48			Sathaye et al 2011a same reference as 2011b	Accepted

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21807	7	23	5	23	19	There is a lot of unnecessary detail here compared to the almost cursory coverage of distributed generation (DG) and smart grids.	Noted - DG and SmartGrids are covered to a degree in Section 7.6, and are noted in a number of other locations.
26856	7	23	1	23	1	replace "renewable" with "renewables".	Accepted.
26857	7	23	34	23	36	This sentence needs to be rephrased as it is not comprehensible.	Accepted.
29180	7	23	16	23	18	For HVDC the viable distance quoted (250 km) is inaccurate (and the term very long lines needs clarity). For example, cable applications in HVAC becomes unviable at distances much lower (usually 70km-150km) and the solution has been HVDC. For example the France-GB HVDC interconnector is ~70 km.	Noted. The undersea and onshore distances are very different - the wording will be updated to reflect this. But note that the France-GB connection is not synchronous primarily for other reasons.
27054	7	23	3	23	4	Delete: "but would be expected to increase transmission losses" or support the statement with facts.	Taken into account - reference to 7.6.1 added.
27055	7	23	5			Replace "also impact" with "reduce". All the technology mentioned in the paragraph reduce losses, which should be reflected in the introduction sentence to the paragraph.	Accepted. Text has been changed.
27766	7	23	37	25	29	It comes with some surprise that wind power is hardly mentioned even though technology advancements (plant sizes, offshore, cost reductions) as well as market deployment have been substantial.	Rejected - In fact, wind power is mentioned on numerous occasions in the text, and in the figure. This section is required to address all RE technologies, so it is true that we cannot dwell on any single technology in much detail. But wind power is represented well, in our opinion.
27056	7	23	40	23	41	Delete (or replace the word 'indicate': "These factors indicate the potential for substantial GHG emissions reduction through many forms of RE deployment." We are beyond the point where 'factors indicate' the potential for GHG reductions through RE. It is an established fact, see for example IPPC's special report on renewables from 2011 (IPPC, 2011a).	Taken into account - sentence removed, as it was unnecessary here.
26795	7	24	11	24	11	"few" CSP plants are opearing at present in at least 11 countries.	Accepted
27057	7	24	15		16	The formulation "to enable deployment at significant scale" indicates - contrary to reality - that it has not happened yet. Replace it with: "and are being deployed at significant scale in many regions of the world". In 2012, more than two thirds of all new power capacity installed in the 27 countries of the European Union was renewable-based (see for example page 6 ff on http://www.ewea.org/fileadmin/files/library/publications/statistics/Wind_in_power_annual_statistics_2012.pdf). In the United States, 42% of all new electricity generating capacity installed was wind energy (see for example http://www.awea.org/newsroom/pressreleases/annual-report-2012.cfm). WInd energy won a significant share in recent public tenders for new power capacity (including fossil and nuclear) in for example South Africa and Brazil.	Accepted - text revised to accommodate general point.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32799	7	24	17	24	18	Define “technically mature” and “economically mature.” This term may be interpreted differently by readers.	Rejected - this terminology is simply taken from the SRREN, with the reference provided. Though there is admittedly no perfect definition of these terms, here we report the classifications provided in the underlying citation, with the approaches and definitions used there. We are space constrained, and simply cannot add more detailed text on these matters.
22549	7	24	17	24	18	"Large scale hydropower…" Does this mean that the authors think smaller scale hydropower are not technically and economically mature? this sentence have been expanded but limited to large scale in re to FOD - an explanation (and ref?) may be needed - suggest to just start with -- Hydropower technologies, for example ----	Accepted - we have changed the text to "most hydropower technologies"
19063	7	24	20	24	21	"--- while ligno-cellulose fuels are at the pre-commercial stage." This is true for making ethanol. But wood alcohol (methanol) was the first building block for the organic chemical industry. It is made from the dry distillation of wood, and has been around for more than 150 years. Methanol can be used directly, it can be transformed into other fuels of higher energy value, and is a 'cheap' hydrogen carrier. Gen gas is another product and this can be transformed into various fuels.	Accepted - we have inserted the word "many"
23598	7	24	24	24	24	Replace the words "may not have" by "have not". This excess of precaution is harmful to the credibility of the chapter. The sentence might by be more precise, if "except in remote sites" would be added at the end of the sentence.	Accepted - we have revised to "have not all" since some solar technologies (solar hot water) are in fact economically competitive in a number of applications and regions.
33869	7	24	25	24	26	Geothermal is NOT a mature technology. A recent NAS/NRC study has geothermal correctly listed as an emerging technology. I understand that power plant technology is mature, however, technologies associated with geothermal well siting, well stimulation, reservoir sustainability, and reservoir creation are not mature. According to the World Bank's recently published geothermal handbook, project risk during exploration and resource confirmation is >90%. This report can be found at http://www.esmap.org/sites/esmap.org/files/FINAL_Geothermal-ES.pdf. The IPCC report, in general, does not address the multi-faceted nature of the geothermal sector.	Accepted - revised text adds nuance as suggested by comment.
32800	7	24	27	24	28	Reference and specifics of tidal barrages which are beyond the conceptual phase.	Rejected - space constraints do not allow for further detail here, but the underlying SRREN citation provides the requested information (aka, operating tidal barrages exist, and use technology that would be considered mature).
32801	7	24	28	24	30	References needed.	Accepted - the opening sentence of this paragraph has been rephrased to make it clear that the entire paragraph is based on the SRREN.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21811	7	24	28	24	30	The text inappropriately suggest that offshore wind is precommercial, which is not the case. Massive GW scale investments in offshore wind have borne out in the EU.	Accepted, in part - the text was, we believe, clear in that we are comparing offshore wind to land-based wind; the text reflects what we understand to be the differences in maturity accurately between those two technologies. That said, we have rephrased the text to focus more on the relative economic cost of on and off-shore, so as to reduce mis-understanding.
21812	7	24	31	24	39	The influence of R&D and public policy on RE deployment is certainly true, but it is equally the case that fossil fuel extraction and conversion has been enormously affected by both R&D, policy incentives, and tax/subsidy regimes. A balanced picture should be presented here.	Noted - this section is focused on renewable energy; questions of balance need to be conveyed to the other sections of the text.
20305	7	24	31	24	39	The role of feed in tariffs could be addressed here	Rejected - policy issues (FiTs, RPS, rebates, net metering, etc.) are addressed later in the chapter to a limited degree, and far more comprehensively in other chapters of AR5. It is outside the score of this section of Chapter 7 to address them.
19062	7	24	31	24	31	Cost of major RE use today is biomass. This is very competitive with fossil fuels and electricity.	Rejected - current text is clear that not all RE technologies have historically had higher costs; cost issues are addressed more comprehensively later in the chapter, and this section is not the place to get into the specific details for individual resources and technologies
23280	7	24	34	25	5	Much repetition from page 11. Can delete.	Rejected - some consolidation has now been achieved, but we have not opted to delete the text because RE deployment is a major development in RE since AR4.
32797	7	24	4	24	7	Quantify price reduction, giving base year.	Accepted, in part - these details are provided later in the chapter, but we now point the reader to that section. We do not report the specific cost reduction here, however, as that is reported later.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19064	7	24	40	24	40	Why exclude so-called "traditional biomass". Its use will expand (2% per year).	Accepted, in part - text revised. Focus is still, to some degree, on modern forms of RE, but text is now less judgemental on traditional biomass.
21132	7	24	40	24	45	Percentage of hydro in RE contribution?	Accepted - text changed
25378	7	24	45	24	45	Note 5 in page 24 should be left in this report, as it is a correct description about RE.	Accepted
36802	7	24	6	24	6	recommend changing "manufacturing supply exceeding demand" to "overproduction" because demand is not exceeded if the price adjusts (which it did).	Accepted - have changed supply to capacity to accommodate the good comment.
25167	7	24	6	24	8	Advise rewrite. See Comment on Chapter 7 entitled: **PV cost data inadequate to support claims and inappropriate for policymaking (includes internal conflict and affects Technical Summary p32 and Summary for Policymakers pg 17)	Accepted - text revised to some degree.
32798	7	24	7	24	9	References needed.	Rejected - references already provided in first sentence of paragraph.
21810	7	24	7	24	9	The evidence for negative learning as well as cost increases should also be mentioned. Learning curves are not inevitable.	Rejected - an excellent point, but one that is already addressed later in the chapter where costs are discussed in greater depth. Outside the scope of this particular subsection of the report.
26858	7	24	40	24	41	More clarity as to what is meant by regional may be required considering the following sentence indicates that RE contributes 20% to global electricity supply.	Accepted - we have removed the word "regional" so that we do not need to then define what we mean by the term.
21813	7	25	16	25	29	This is interesting, but is another example of the lack of systematic and standardised coverage of the mitigation options, as similar findings from the scenarios literature are not drawn for fossil fuels, nuclear, fuel switching etc. Either this analysis should be included for all mitigation options, or none.	Accepted, in part - text deleted, at least as it relates to scenarios literature. However, some of the main points here are moved up in the section but retained, as they provide important context for understanding RE mitigation technology options.
26613	7	25	16	25	21	The paragraph should reference that renewable energy technologies working together can often contribute more at a system level than single technologies. For example, storage hydropower and pumped storage hydropower can offer significant balancing services at a system level to more variable technologies such as wind and PV.	Rejected - while we agree with this comment, it is better addressed in the infrastructure/integration portion of the chapter.
21133	7	25	16	25	21	Are the identified sources expected contributions larger than the contribution from hydro?	Accepted - this is based on incremental contributions, and has been made more clear in the text.
21134	7	25	16	25	21	Transportation fuel and heating	Accepted - the statement made here is based on total primary energy, so includes transport and heating; the text has now clarified this point.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33006	7	25	16	25	29	These paragraphs discuss scenario literature, and therefore seem misplaced in a section that is simply intended to present mitigation options. Would be better placed in 7.11	Accepted, in part - text deleted, at least as it relates to scenarios literature. However, some of the main points here are moved up in the section but retained, as they provide important context for understanding RE mitigation technology options.
23281	7	25	19			Be more specific on chapters and AR4 or delete as not useful as is. Footnote 7 is repetition. Delete.	Accepted
19769	7	25	22	25	29	Private (and public) vehicle electrification is a way to directly reduce emissions from the transport sector; perhaps green certifications for charging stations would do that. Also this section has to be linked with the industry chapter (automobile manufacturing) and any further mention on electricity storage in this chapter.	Accepted - a note to see other AR5 chapters has been added.
21898	7	25	22	25	29	Electric cars have a large potential in electrifying the transport sector and allowing it to be "fuel" by low carbon electricity.	Noted - no obvious change in text needed based on this observation.
36803	7	25	24	25	24	Should also reference GEA (2012)	Rejected - earlier text now deleted as per other comments, and replaced with alternative text.
23282	7	25	25	25	26	Not true. Electricity used widely for transport too - rail, metros, trams, trolley buses	Accepted - text revised to clarify point that we are trying to make.
31656	7	25	26	25	29	This is a 'chicken and egg' type argument as it is equally likely that the moves to electrification of transport etc may be constrained by the availability of RE sourced power. It is questionable whether reheasrsing one side of this issue here is of value.	Rejected - though the point is understood, the use of "may" provides the proper context here in our view. We believe it is appropriate to indicate that absent electrification of transport, RE may have a hard time penetrating as much in TPES.
32802	7	25	8	25	11	Some of this is repeating the sentiments expressed earlier on the reduction of PV costs. Quantify the rates of growth and provide references.	Accepted - links have now been made to section 7.8, and a reference has been added.
26826	7	25	8	25	8	After "...2011 (REN21, 2012).", please add "Total RE investments in developing countries reached USD 89 billion; representing a 10.6% increase in their value compared to 2010 (Source: pg 23, IRENA (2012), Financial Mechanisms and Investment Frameworks for Renewables in Developing Countries (pg. 22), http://www.irena.org/DocumentDownloads/Publications/IRENA%20report%20-%20Financial%20Mechanisms%20for%20Developing%20Countries.pdf)".	Rejected - By agreement, investment amounts are addressed in a later section of Ch 7, and space constraints do not allow additional information to be added here.
20479	7	26	10			2010: 2,756 TWh (IEA 2012g) but IAEA quotes 2,630 TWh (IAEA 2013); please make consistent. The development in 2011: 2,517 TWH (IAEA2013) is worthewhile to mention.	Accepted - text revised for consistency.
21135	7	26	13	26	18	Why is this important from CO2 abatement perspective?	Rejected - knowledge of existing reactor types is important from fuel cycle perspectives, potential safety concerns, and direction of future deployment.
23284	7	26	15			"pressurized water reactors" - don't use upper case just cause an acronym is quoted - also in para below.	Accepted - text revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24640	7	26	19	27	4	The usefulness of this paragraph is marginal- suggest it could be shortened if shortening the chapter	Rejected - currently available nuclear technologies from multiple vendors and countries, and evolution to new technologies with greater passive safety features have important implications on nuclear costs, safety, widespread applicability, and overall acceptance.
21899	7	26	19	26	29	Nearly all new reactors are being built in Asia.	Noted - not all are being built in Asia; further breakdown of reactors currently under construction provided.
21816	7	26	24	26	25	The massive cost/time over-runs should be mentioned, as these are relevant for near-term mitigation potentials of new designs.	Rejected - While some have been delayed with cost overruns, many of the recently completed reactors and those under contraction are within cost and time budget. There are 69 reactors currently under construction and many more planned.
25379	7	26	3	26	5	Note on the Table 7.3 should be left in this report, as it is a correct description about RE.	Accepted
21814	7	26	3	26	5	Table legend refers to a 'better' metric of RE contribution whereas a supply metric is simply different not better. The GW capacity metric is a good relative indication of capital investment and capital stock, and also links to the learning curve metric of 'experience'. (See also footnote 5 on page 24).	Rejected - the value of RE as a carbon mitigation tool comes directly from its production of electricity, and therefore displacement of fossil energy. As such, energy supply is, in our view, the better metric for the purpose of an IPCC report.
23602	7	26	3	26	5	Would it not be fair and policy relevant to give an order of magnitude of the ratio between capacity and actual supply for each type of energy, wich can reach a factor 3 or 4 for wind energy ?	Rejected - the caveats provide the needed context, and the share of RE supply in electricity production and TPES is already provided elsewhere in the chapter. We deem this sufficient, especially given space constraints. As such, we have not added typical capacity factors to the table.
23283	7	26	3		5	Note is a repeition of footnote 5. Don’t need both.	Rejected - previous commenters have insisted that both notes be retained.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
29181	7	26	3	26	5	Strongly agree with the foot note to table 7.3 (the generating capacity figures for renewables without capacity factors are very misleading), but if you wanted to improve this situation for some technologies, you can actually quote the typical capacity factors (these are for the UK and a lot of the technologies, e.g. wind, in DUKES).	Rejected - the caveats provide the needed context, and the share of RE supply in electricity production and TPES is already provided elsewhere in the chapter. We deem this sufficient, especially given space constraints. As such, we have not added typical capacity factors to the table.
32804	7	26	34	27	1	Reference needed.	Taken into account - reference added.
21817	7	26	34	27	4	This section on modular nuclear reactors is highly speculative (and innovation dependent) at best, and naïve techno-optimism at worst. Given the absence of coverage of technologies which are being rolled out at scale (e.g., smart grids), this text should be shortened or deleted.	Rejected - Many small sized reactors are in operation today, and many countries have interest in the SMR. Korean SMR has been licensed and US SMR licenses are under review by the US NRC. Text includes "widespread adoption remains uncertain."
23737	7	26	6	27	38	Too much attention dedicated to nuclear power. Why not more on other energy sources of interest. Recommendation is to reduce text on nuclear energy.	Rejected - nuclear energy is an important GHG mitigation option; RE and CCS have been the subject of IPCC special reports in the past. Their treatment therefore has been reduced in size.
19065	7	26	6	28	32	Nuclear energy. This section could be condensed	Rejected - nuclear energy is an important GHG mitigation option; RE and CCS have been the subject of IPCC special reports in the past. Their treatment therefore has been reduced in size.
27767	7	26	6	28	32	The mining for Uranium is accompanied by significant social and environmental costs. Shouldn't this be discussed as an important associated effect?	Taken into account - the adverse side effect of U mining is noted in Table 7.3 in 7.9 (discussing co-benefits and adverse side effects).
32803	7	26	7	26	7	Reference needed.	Accepted - reference added.
21815	7	26	7	26	18	This is descriptive and can be deleted.	Rejected - provides necessary background on current nuclear energy use and emissions reduction contribution.
23736	7	26	7	26	7	It will be more useful to quote the number of countries and, if necessary, mention the complementary specific regions.	Taken into account - text revised.
36804	7	26	7	26	7	"Region" is not defined, which makes this sentence meaningless.	Taken into account - text revised.
20478	7	26	8			It should read "437 nuclar recators operational" as quoted in the IAEA database and not "in operation" as out of the 50 "operational" Japanese reactors only 2 are actualy in operation.	Accepted - text revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33042	7	26				This section covers topics that seem too broad for 'Mitigation Options' (Section heading), discussion safety, waste disposal, accidents, etc, most of which would be better covered in 7.9. It may be an option to save space, merging most of the discussion on those topics to 7.9 and simply including highlights here, referring to the more comprehensive discussion.	Noted - safety, waste disposal, fuel cycle, etc. directly affect choice of nuclear technology and therefore, its potential as a mitigation option. Some discussion is necessary in 7.5.4. Other aspects of safety, accidents, etc. move to 7.9.
32805	7	27	16	27	19	Reference needed.	Taken into account - reference added.
20446	7	27	22	27	26	A successful strategy of separation and transmutation could result in a higher societal acceptance of nuclear energy use, which is affected not least by the problems of long-term storage and permanent disposal of high level radioactive waste.	Noted - text includes investigation of alternative fuel cycles.
36806	7	27	32	27	32	Thorium cycles deserve a bit more explaining, even if in passing. Probably should be placed earlier under resource estimates.	Taken into account - text expanded under 7.4 Resources and additional discussion provided in 7.5.4.
33765	7	27	34			… Higher economic costs, increased complexities, and associated …	Editorial - corrected
23285	7	27	34			Old reference. Could use GIF, 2009 perhaps?	Accepted - new reference added
21819	7	27	39	27	50	It suffices to state that there is no current solution to the challenge of long-term storage. This whole section on nuclear is too long.	Rejected - multiple options for waste management are currently applied.
21900	7	27	39	27	50	there is lack of best practice with regards to the treatment of nuclear waste.	Rejected - multiple options for waste management are currently applied.
27058	7	27	39	27	5	This section on waste storage states: "There is not a commonly accepted single worldwide approach to dealing with the long-term storage and permanent disposal of high-level waste.". That is certainly true but less relevant than the fact that such storage has never been achieved anywhere in the world over the 50 years of nuclear energy history. This highly relevant section on high-level waste storage must as a minimum point out that such story has never been achieved anywhere in the world. Much of the rest of this section can be shortened or left out especially the parts that deal with technology dreams that - if they are acheived - will not be commercially available this side of 2030.	Rejected - multiple options for waste management are currently applied. The choice of waste management strategy is country specific. Finland, Sweden and France are likely to have operational disposal facility by 2020-2025. HL waste is being reduced through recycling as well. Interim storage of spent fuel provides cooling and decay benefits for reducing demand on geologic repository.
30076	7	27	40			(waste) and so up to now worldwide not one singel permantent disposal of high-level waste is build and put into action.	Rejected - multiple options for waste management are currently applied. The choice of waste management strategy is country specific. Finland, Sweden and France are likely to have operational disposal facility by 2020-2025. HL waste is being reduced through recycling as well. Interim storage of spent fuel provides cooling and decay benefits for reducing demand on geologic repository.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26039	7	27	5	27	8	" Reliance on U-235, a relatively scarce uranium isotope, as the primary source of nuclear fission with the bulk of fissionable U-238 relegated to the waste stream implies that the current nuclear fuel cycle does not effectively utilize available uranium resources." RECOMMEND: Deletion or replacement with "The majority of current reactors extract energy from fissile U-235, an isotope with natural abundance of 0.72%. The fissionable U-238, with a natural abundance of 99.28%, is not fissile and therefore does not directly take part in the nuclear chain reaction. However, up to one third of the energy produced from indirectly from U-238, from the transformation of U-238 into fissile Pu-239. U-238 could be used to generate more fissile fuel in fast reactors, which could greatly extend the energy that could be produced from existing uranium resources. Most of the U-238 used in coventional nuclear fuel is unused and can be recoved and recycled through reprocessing." JUSTIFICATION: U-238 is fissionable, but is not fissile, it is therefore not intended to be the prime source of energy in an LWR reactor. The unused U-238 is is not consumed and could be used in fast reactors, therefore the presence of U-238 in nuclear fuel is not wasting this resource. Used fuel is not a waste stream. The U-238 can be recovered, the Pu-239 produced can be separated and reusued in MOX fuel. Only the very small percentage of fission products produced are truely waste. An isotope with a natural abundance of 0.72% is not "scarce". The text should simple state the natural abundance.	Taken into account - text revised.
21818	7	27	5	27	26	Largely repetitive of earlier text (e.g., Section 7.4.3) and not specific to nuclear as a mitigation option. Delete.	Taken into account - text revised to minimize redundancy in 7.4 Resources and 7.5 Mitigation technology options
36805	7	27	5	27	26	Again should say "weapons proliferation", the connection should be explicit. The "100 years" in l. 9, is somewhat at odds with the "more than 90 years" used earlier in 7.4.3. Should be explicit and consistent.	Taken into account - text revised for consistency. Nuclear energy use raises proliferation concerns, but does not directly contribute to weapons proliferation.
27062	7	28				Delete the word "significant". It is ambiguous and 68 GW for a technology that, probably at best has a 15 year average construction time (according to the IAEA definition of "under construction"), i.e. 4.5 GW per year, can not be considered significant compared to the IEA's estimation of 710 GW of renewable electricity capacity between 2011 and 2017 (see http://www.iea.org/Textbase/npsum/MTrenew2012SUM.pdf). Of the app. 65 reactors reported to be 'under construction', 20 reactors have been 'under construction for more than 20 years (see for example http://www.worldwatch.org/global-nuclear-generation-capacity-falls).	Taken into account - text revised. Most reactors under construction are new and have recent start dates. According to the IAEA, only 11 reactors have start dates more than 20 years. Nameplate capacity comparisons should include annual electricity generation capacity factors.
24340	7	28		31		The CCS mitigation strategy, in my opinion, is excessively valued in the Chapter 7. This aspect should be revalued, therefore CCS is still very connected to economical reasons (e.g., larger pressure for secondary extraction of oil). In other words, besides real economical obstacles, CCS can, in fact, to aid in the expansion of the oil production. Its not clear yet (under the scientific perspective) if CCS is economically viable (even in long term scenery) and if it is more an interesting strategy for the economical success of the oil industry than for climate chnage mitigation. In such context, I suggest that the content of Section 7.5.5 should be reduced for just a page.	Noted. No change required as the reviewer did not bring forward citations or other credible information to substantiate the requested changes.
23286	7	28	1		2	Better as "...with the cancellation of the Yucca Mountain nuclear waste repository proposal in Nevada (CRS, 2012)." Then delete next sentence.	Taken into account - text revised
23290	7	28	1		4	How can 2011 references give data "as of early 2013"?	Taken into account - reference updated.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21403	7	28	10	28	14	Many countries are progressing the nuclear energy development, only Germany changed the policy. This text should be deleted because it has not the reasonal explanation.	Noted - Fukushima discussion moved to 7.9 on risks.
27060	7	28	12			There are others but at least add "Italy and Switzerland" after Germany.	Noted - Fukushima discussion moved to 7.9 on risks.
27061	7	28	13	28	15	Delete the sentence starting with "The accident...". It implies that Fukushima had no effect on nulcear deployment, whatsoever, in any countries where i) power demand is growing or ii) where there is 'an interest diversification' or ii) where there is a motivation for GHG reductions. It seems unlikely - especially given that the loose definition probably covers all nations of the world. If not deleted, the nations that the text referes to must be named and the definition radically changed to have any scientific interpretation.	Noted - Fukushima discussion moved to 7.9 on risks.
21137	7	28	13	28	18	Impact of Fukushima in Germany's and Switzerland's decisions on nuclear	Noted - Fukushima discussion moved to 7.9 on risks.
36808	7	28	13	28	16	Suggest softenting this statement. The conclusion is not knowable given the lack of a strong counterfactual.	Noted - Fukushima discussion moved to 7.9 on risks.
20480	7	28	17		18	It would be worthewhile mentioning that 9 of those reactors are listed as under construction since more than 20 years and anothr 4 have been listed for more than 10 years. In addition 43 projects do not have an official IAEA start-up date, which make it difficult to judge if they are on schedule or not.	Noted - Construction start dates provided in IAEA 2012 (Nuclear Power Reactors in the World).
23288	7	28	21			Would be good to know what type and scale of plants are being built in China. Smaller capacity systems being developed (around 300 MW I think) need a comment somewhere. See for example: http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Power-Reactors/Small-Nuclear-Power-Reactors/	Taken into account - text revised.
25380	7	28	22	28	26	These sentences should be left in this report, as they are correct descriptions about effectiveness of nuclear power in GHG emission reduction.	Noted - text kept.
25710	7	28	22	28	26	This section should be kept in the final version report because it is important to explain that nuclear power has contributed largely to reduce CO2 emission in the world and has a merit to reduce CO2 emission more economically than renewable energy, as described in (Weisser, 2007, page1). This literature is listed in the No2 line of this table.	Noted - text kept.
23738	7	28	22	28	24	Instead of providing qualitative contribution of nuclear energy to green environment, present the amount of GHG emissions savings, based in life cycle analysis, due the use of such energy.	Rejected - section 7.8.1 discusses life cycle emission and is referred to in text. Further discussion limited by page constraints.
25619	7	28	24	28	29	See comment No.16, 17.	Not clear which are No. 16 and 17 comments.
19640	7	28	28	31	7	This section on CCS makes no mention of the important topic of energy penalty. I suggest the following: "The energy penalty for CCS has been estimated at up to 48.5% for 100% capture and compression to liquid CO2 (Page et.al, 2009). However, most energy penalty values reported in the literature have arisen from simulation studies (Page et.al., 2009), and full-scale implementation of CCS on electricity generation plants is required before a comparison of measured data with these predictions can be made." Reference: Page, S.C., Williamson, A.G. and Mason, I.G., 2009. Carbon capture and storage: Fundamental thermodynamics and current technology. Energy Policy 37 (9), 3314-3324.	Rejected. No change required as discussions of the energy penalty associated with CCS are discussed adequately in other sections of Chapter 7.
20447	7	28	32	28	32	Concerning the long-term perspective of nuclear energy use, attention should be drawn to high experimental efforts in the field of thermonuclear fusion power, for example in national (MAST, UK), European (JET) and International (ITER) projects. See also comment 7.	Noted - We do not think that fusion energy should be included in 7.5.4 that focuses on energy from nuclear fission. Commercial energy production from fusion energy is too speculative at this time.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19066	7	28	33	31	7	Carbon capture and storage. Little mention is made in this section of the use of trees for carbon capture. The cost of a forest plantation/woodlot or scattered trees is $500 -1000 per hectare equivalent. If the average growth is 12 m3/yr, (7.2 odt wood equivalent to 3.6 tC)then a 10 year-old plantation, with an equl distribution of age-clases will on average store 48 tC in wood and soil and yield 3.6 tC per year. A 50 ha plantation will store on average, 3,400 tC and have an annual yield of 180 tC equivalent to 360 dry t of wood.This is a tropical country example. Likewise, in temperate countries, a 50 year-old plantation, with an equal distribution of age classes will on average store 167 tC per ha in wood and forest soils and again yield 3.6 tC each year for use. Thus, a 50 ha. plantation will store on average 8,350 tC and have an annual yield of 180 tC equivalent to 360 dry t of wood. As mentioned previously this will bring work and cash to the rural poor and greatly assist in poverty aleviation. Why is so little mentioned made of CCS in forests in this section. Wih CCS for coal, about 15-20% of the energy has to be used in the process of carbon capture and storage and there is no certainty that all the storage areas will be 'water tight'. Usually the wood can be grown near to where it is used.	Rejected: The reviewer is using the term "carbon capture" in a way that is not consistent with the IPCC's terminology that distinguishes between carbon dioxide capture and storage at industrial and power facilities and carbon stored in above ground and below ground biomass.
36809	7	28	33	31	7	Section should provide an update on the current status of CCS, including the emergence of numerous large-scale integrated CCS projects - per the Global CCS Institute (GCCSI), at least 75 as of September 2012, in various phases of planning, construction, and operation. See/cite "The Global Status of CCS: 2012" - http://www.globalccsinstitute.com/publications/global-status-ccs-2012	Accepted. This data point has been updated.
33766	7	28	34			… (CCS) systems exist and are …	Accepted. The restructured first two paragraphs of Section 7.5.5 hopefully now make it clear that CCS systems do exist (outside of the electric power sector).
21821	7	28	34	31	7	The section on CCS is very long, overly-detailed, relies too much on the industry advocacy body, and should be substantially shortened to reflect its relative weight in mitigation portfolios (and its unproven status). As noted before, it would be helpful if a common and standardised structure was used for each mitigation option, e.g., (1) short technical description (2) trends since AR4, (3) issues/constraints	Noted. Section 7.5.5 has been significantly restructured and shortened. References to "industry advocacy groups" have been removed except for trivial points such as how many CCS demos are operational which is something that a group like this is capable of keeping track of.
31657	7	28	34	28	36	Although the technological elements for each part of a CCS system may exist it needs to be explained that when fossil (or even biomass as alluded to in FAQ 7.2) fuelled plant is concerned there remain technology gaps for efficient, cost effective capture and that there is a strong relationship betwen the fuel utilisation technology and the requiremetns of the capture technology.	Accepted. The need to make progress on CO2 capture systems has been brought out more clearly in the revised and restructured Section 7.5.5.
23289	7	28	34		36	More repetition	Rejected. I do not see how this is repetitive. This is a key point that is used to define what CCS is.
36811	7	28	34	28	49	This paragraph self-contradicts: The first sentence correctly states that CCS system components "exist and are in use today by [various, primarily non-power] sectors." The last sentence erroneously pronounces no such deployment. Suggest removing the last clause (lines 48-49), or editting into a correct statement - e.g., clarify that power sector CCS deployment, expressly for GHG mitigation, would require scale-up of existing industrial implementations that serve primarily commercial/non-environmental objectives. Also, there is the need to incorporate non-technical costs.	Accepted. The text has been revised significantly to make the points brought out by this review comment more clearly.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36810	7	28	34	31	7	This entire section (7.5.5) seems out of order. Early on, it talks about end-to-end systems (p. 28). Then it talks about geologic sequestration (p. 29). Then it goes on to discuss capture (p. 30, top half), and then it reverts to talking about geologic sequestration. Please consider reordering themes, by process chronology.	Accepted. Section 7.5.5 has been significantly restructured to improve the flow and readability.
23739	7	28	36	28	36	"A complete end-to-end CCS system". What end-to-end system means???	Rejected. The sentence in question defines what an end-to-end system would be.
24220	7	28	37	28	39	As Iron & Steel making plants are also important emission source(Table 2.3 in IPCC SRCCS 2005) , this should be added.	Noted. The role of CCS in decarbonizing the industrial sector is dealt with in Chapter 10.4. The revised section 7.5.5 now directs readers to this section 10.4
33767	7	28	39			… CO2 into suitable …	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements to Section 7.5.5
36812	7	28	44	28	44	Possible over-/mis-use of "special." Suggest refering simply to "circumstances" (already implying situational specificity) that endow CO2 with, say, "process and/or commercial [instead of 'special'] value."	Accepted. The sentence has been reworded to hopefully clarify meaning.
31433	7	28	45	29	4	Although CCS has not been applied to a large commercial fossil-fired electricity generation facility, CCS has been commercialy deployed to other related sectors such as gas processing (Global CCS Institute, table 1 in http://www.globalccsinstitute.com/publications/global-status-ccs-2012/online/47981).	Accepted. The revised and restructured Section 7.5.5 now hopefully makes this distinction clear.
21106	7	28	45	28	45	It should be mentionned that in the case of tertiary recovery of hydrocarbons, this process leads to more fossil fuel beeing exctracted and burned, so consequently to additional GHG emissions	Rejected. Given space constraints, we are unable to describe the literature that looks at the life cycle implications of use CO2 for EOR. It is a bit more complex than what the comment suggests as it matters a great deal whether the oil produced from CO2 EOR is replacing oil derived from tar sands or light sweet crude produced using only primary production methods.
21138	7	28	45	28	45	Explain what you mean by tertiary recovery of hydrocarbons	Rejected. Given space constraints there is not room to define every term here. The reference at the end of that sentence contains a detailed discussion that would define this for an interested reader.
36813	7	28	47	28	47	Recommend removing "fossil-fired" source descriptor or generalize - e.g., substitute "hydrocarbon-fired" - to equally cover BECCS, consistent with that option's integrated treatment, alongside fossil CCS, throughout the Report.	Accepted. Sentence has been revised to help clarify meaning and improve readability.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
29660	7	28	48			The Global CCS Institute should absolutely not be cited in AR5, as it is an advocacy organization.	Accepted. Citations to GCCSI have been removed to the extent possible. GCCSI is no longer cited for any important technical information.
26918	7	28	48			The Global CCS Institute should not be used as a citation, as it is an advocacy organization.	Accepted. Citations to GCCSI have been removed to the extent possible. GCCSI is no longer cited for any important technical information.
29783	7	28	48		49	The statement - "nor has there been commercial deployment of CCS in the many 48 varied industrial (i.e., non-power) sectors where CCS is seen as a key for reducing CO2 emissions." is statement which is not accurate. There are a lot of industrial application that already employed CCS - albeit mostly in EOR operation. A case in point - Dakota SNG Plant is one of the largest commercially operated CCS attached to Weyburn. This is also true to the ERDOS project in China - where Direct Coal Liquefaction plant captures around 100K per year for EOR operation.	Accepted. Text has been changed accordingly.
21820	7	28	6	28	32	Ditto: too much extraneous detail. The imporatnt point for nuclear as a mitigation option is that considerable challenges on waste storage, safety, etc. remain.	Rejected - nuclear fission contributes to energy production today. Discussion of fuel cycle issues and reactor technologies is relevant to the potential of nuclear energy as a mitigation option.
27059	7	28	6	28	6	Delete "unprecedented". (The Tōhoku earthquake is the fifth largest earthquake recorded.)	Taken into account - text revised. Fukushima discussion moved to 7.9 on risks.
23287	7	28	6		18	Again, much repettion- could reduce	Taken into account - text revised to remove redundancy.
36807	7	28	6	28	6	This earthquake was not "unprecedented." Since 1952 there have been 5 earthquakes with magnitudes at 9.0 or larger, the largest at 9.5 (1960 in Chile). Suggest replacing "unprecedented" with "extremely large"	Taken into account - text revised. Fukushima discussion moved to 7.9 on risks.
21136	7	28	7	28	7	Is the reference to the Prime Minister of Japan necessary?	Taken into account - text revised. Fukushima discussion moved to 7.9 on risks.
31660	7	28		31		This section needs to be restructured to make it more accessible to the reader. It should start with introducing the concept and then cover the key aspects of capture, transportation, storage and monitoring in sequence. This should also enable some repetition to be avoided and space to be saved.	Accepted. The text has been revised.
27063	7	28	33	31	7	Large parts of the section can be deleted. It seems very odd Chapter allocates so much space to a technology (CCS) that will not be deployed at any significaant scale - and thus have little impact on GHG mitigation this side of 2030. It is equally odd that so little space is allocated to the cheapest and largest mitigation option: efficiency.	Accepted. Section 7.5 has been shortened and substantially restructured to improve readability.
29632	7	28	33	31	7	Confer this study on leakage of CO2 from geologically storage and temperature effects : Torvanger, Grimstad, Lindeberg, Rive, Rypdal, Biletvedt Skeie, Fuglestvedt, and Tollefsen, 2012, Quality of geological CO2 storage to avoid jeopardizing climate targets, Climatic Change, 114:L 245-260.	Accepted. Thank you for pointing out this paper. It is quite useful and has been cited in the revised Section 7.5.5.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24294	7	28	34	31	7	It is suggested to add description about CO2 abatement through the utilztaion of CO2.	Noted. The IPCC SR on CCS (2005) discusses this topic extensively. It is the author's opinion that there have not been significant technological progress in the field of CO2 utilization and therefore given space constraints this will not be addressed here as the IPCC SR on CCS serves as an adequate reference.
31533	7	28	34	31	7	It is suggested to add description about CO2 abatement through the utilztaion of CO2.	Noted. The IPCC SR on CCS (2005) discusses this topic extensively. It is the author's opinion that there have not been significant technological progress in the field of CO2 utilization and therefore given space constraints this will not be addressed here as the IPCC SR on CCS serves as an adequate reference.
23612	7	28	34	30	21	This section on CCS seems to lack description on the application of CCS technology on distributed energy systems. Hereby I suggest to add the following paragraph to address this topic: “While the majority of CCS research focuses on large point sources, it may become necessary to apply CCS for smaller scale distributed generation systems. Kuramochi et al. (2013) performed a review on the state-of-the-art CO2 capture technologies for distributed energy systems with CO2 compression and transport also taken into consideration. The study concludes that although there is a wide variety of technologies and operational patterns, CO2capture from distributed energy systems is not prohibitively expensive and has a significant cost reduction potential in the long term (year 2030 and beyond).” Reference: Kuramochi, T., Ramírez, A., Turkenburg, W., Faaij, A. Techno-economic prospects for CO2 capture from distributed energy systems. Renewable and Sustainable Energy Reviews, 19 (2013) 328-347. http://dx.doi.org/10.1016/j.rser.2012.10.051	Rejected. This point was made in an earlier draft of Section 7.5.5 but was dropped due to stringent page length limits. It is a valid point but given the amount of space available it is a nuance that cannot be addressed.
21405	7	28	37	28	38	"Natural gas processing" should be added to the examples of stationary point sources, because the most of operating CCS demonstration projects include natural gas processing.	Accepted. This is now clearly communicated in the revised section 7.5.5.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21406	7	28	39	28	40	"The surface" should mean both ground surface and sea floor. So, "800m deep in underground" could be better.	Rejected. The reviewer makes a mostly valid point. However, there are some papers that suggest the pressure caused by a few hundred meters of ocean water could allow the CO2 to be stored in geologic formations shallower than 800m below the seafloor. The word "typically" in the sentence in 7.5.5. in question is meant to encompass scenarios like this.
23918	7	28	48	29	4	Conflict in statements over these lines. Clarity of intent required please. And there has been commercial scale deployment of CO2 to avoid government CO2 taxation in Norway.	Accepted. Section 7.5.5 has been significantly restructured and these apparently conflicting statements are no longer in conflict.
20288	7	29				It should be made clear how many of the large end-to-end projects are on fossil fuelled power plants, as compared to other industrial facilities.	Accepted. This passage has been significantly rewritten to hopefully improve clarity and readability.
32806	7	29	1	29	22	Is there any data on the real-world efficiency of these CCS projects, including: cost per tonne of CO2 captured and stored; energy required to capture and store and associated emissions? The answers to these questions are important for an informed discussion around the merits and pitfalls of CCS.	Noted. Given space limitations. These points are addressed in Chapter 7. All of this information is not in section 7.5 as the many pointers to other parts of chapter 7 contained in Section 7.5.5 make clear.
30541	7	29	1	29	4	On CCS plants, lets be clear that none of the ones mentioned are in the power sector and none of them have climate change as a major motivator for their operation. Hence it is important not to misrepresent the terrible state of play in the deployment of CCS technology.	Rejected. Sleipner and Snovit are certainly motivated by a requirement to pay a tax for CO2 emissions from offshore Norwegian oil and gas production.
31659	7	29	12	29	22	Key challenges for MMV include monitoring of under sea bed stores (particularly with regards to leak detection), availability of suitable down hole instrumentation and interpretation of measurements of conditions inside stores given that even a closed store remains a dynamic system with CO2 mineralisation etc affecting their state over time.	Noted. Given space limitations and many comments from other reviewers that section 7.5.5 is too technically detailed, the suggested inputs are to specific for inclusion.
31658	7	29	14	29	18	This sentence does not make sense, it appears that some words may have been omitted.	Accepted. The sentence has been reworded to hopefully clarify meaning.
33768	7	29	15			… a storage formation allow …	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements to Section 7.5.5
21139	7	29	23	29	38	Reported in literature but concerning or not?	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements to Section 7.5.5

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25937	7	29	29	29	33	These papers all stress the need for good CO2 storage site selection. The technical literature is also quantifying.	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements to Section 7.5.5
29659	7	29	4			The Global CCS Institute should absolutely not be cited in AR5, as it is an advocacy organization.	Accepted. Citations to GCCSI have been removed to the extent possible. GCCSI is no longer cited for any important technical information.
26917	7	29	4	29	6	The Global CCS Institute should not be used as a citation, as it is an advocacy organization.	Accepted. Citations to GCCSI have been removed to the extent possible. GCCSI is no longer cited for any important technical information.
25938	7	29	41	29	44	…storage. Field experience…	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements to Section 7.5.5
21107	7	29	44	29	48	« Long-term » should be defined here. While it is true that over period of several hundreds or thousands of years, CO2 is more and more strongly linked to the geological formations, it should be stressed that over a period of a few decades, the risk profile does not decline, as shown by INERIS, wich states that sudden surface events (e.g. eruptions of gas) can be caused by slow underground processes. See http://www.ineris.fr/centredoc/95145-11842b-stockage-co2-2.pdf p. 57	Rejected This paper appears to be an outlier and is not consistent with the broader body of peer reviewed literature that says once CO2 injection has stopped the risk profile immediately begins to decline.
21407	7	29	1	29	4	"As of early 2013" is not match with the years of refrences quoted in this sentence, such as "Global CCS Institute, 2011". "Global CCS Institute, 2012" should be better for quotation. In this case, this sentence should be changed to "Around the world, eight large-scale CCS projects are storing about 23 million tonnes of CO2 each year as of September 2012.", as stated in the Executive Summary of "Global CCS Institute, 2012".	Accepted. Sentence has been revised. This is no longer an issue.
29182	7	29	1	29	4	Clarification of the type of projects will be useful, TS.4.2 page 31, lines 7, 8 state there are no large commercial plants as of 2013.	Accepted. This passage has been significantly rewritten to hopefully improve clarity and readability.
20898	7	29	23	29	38	Please include the following article which provides further insight in pressure impact of CO2 storage. In contrast to other publications in this paragraph (energy procedia), it is peer-reviewed: Schäfer, F., Walter, L., Class, H., & Müller, C. (2011). The regional pressure impact of CO2 storage: a showcase study from the North German Basin. Environmental Earth Sciences, 65(7), 2037–2049. doi:10.1007/s12665-011-1184-8	Accepted. Article is cited.
23692	7	29	8	29	11	Is possible to delete : this example is not very substantiated	Accepted. This passage has been shortened and rewritten.
21108	7	30	11	30	21	It should be mentionned that LCOE increases substantially if CCS is not used in baseload. ZEP has shown in his report on cost of CCS that decreasing from 7500 hours per year to 5000 hours per year increase the LCOE by 19 EUR/MWh. See http://www.zeroemissionsplatform.eu/downloads/811.html p. 9	Noted. This text has been removed from Section 7.5.5
36814	7	30	11	30	14	Actually variable costs can also be high due to related factors (e.g., drop in plant efficiency with CCS).	Noted. This text has been removed from Section 7.5.5

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36815	7	30	11	30	16	Suggest the authors reconsider the statement on Line 11 of "Low variable costs"? CCS does not have low variable costs, especially compared to the low-carbon alternatives of renewables and nuclear. CCS requires additional fuel input (raising variable fuel costs by a factor of 20% - 50%, depending on the analysis), as well as additional O&M on the equipment and likely re-stocking of reagents (solvents, etc.). On the other hand, nuclear fuel is very inexpensive (compared to the capital cost of an LWR), and the marginal operating costs for wind, solar and geothermal energy are basically zero.	Noted. This text has been removed from Section 7.5.5
21822	7	30	12	30	13	Avoid introducing new technical jargon. Driving down the dispatch curve = move from peak load to base load?	Noted. This text has been removed from Section 7.5.5
25939	7	30	14	30	17	...2005). Near-term early deployment of CCS are likely to arise…	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements to Section 7.5.5
21901	7	30	17	30	21	Even though the best first commercial applications for CCS could be on industrial plants that have high purity CO2. Using them as first demonstration plants instead of coal-fired power stations would be cheaper because their fumes do not require difficult purification processes.	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements to Section 7.5.5
29784	7	30	2		2	"oxy-based capture" - this should be replaced with "oxyfuel combustion with CO2 capture". The original text is not the right name for this class of technology and could be referred to as oxygen enrichment combustion as well	Accepted. Change has been made.
23740	7	30	20	30	21	Add Pacca, S. and J. R. Moreira, 2011. A Biorefinery for Mobility? Environ Sci Technol. 2011 Nov 15;45(22):9498-505. in the reference list.	Rejected. It is not clear how this paper fits in with this passage. More importantly this passage no longer appears in Chapter 7.
24641	7	30	22	30	38	The usefulness of this section is marginal- suggest it could be shortened if shortening the chapter	Accepted. This section has been significantly shortened.
33044	7	30	22	30	44	The discussion on storage capacity for CCS is very interesting and useful. Would it not warrant its own sub-section in 7.4, as it is ultimately a discussion of resource?	Noted. Space limitations do not allow for a fuller discussion.
25940	7	30	25	30	34	...in many regions of the world. Dooley (2012) estimates…	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements to Section 7.5.5
31434	7	30	27			After "of the North Sea (NPD, 2011)", the sentence should continue with: "and 5.5 GtCO2 in the Norwegian Sea (NPD, 2012)" Reference: http://www.npd.no/en/Publications/Reports/CO2-storage-altas-Norwegian-Sea/	Noted. This text has been removed from Section 7.5.5
31245	7	30	28	30	37	Its quite annoying (to me) to see CO2 emissions given as GtCO2 rather than GtC, as it makes the accounting of C flows more difficult (which is why the climate science community for the past 50 years or more has used GtC). Anyway, I know that the policy community isn't going to change what they do, but here at least it would be useful to give the storage potentials in GtC (alongside GtCO2) because earlier the fossil fuel reserve and resource sizes are given in GtC (which is the only metric that makes sense for those).	Rejected. Standard IPCC practice is to use CO2 based units in this context.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
29785	7	30	4		10	I suggest that this paragraph should include a commentary to discuss about the complexity of deploying CCS in industrial application with some industry requiring the considerations to address global competitiveness issues that could result to economic CO2 leakage if CCS is required without a level playing field. Furthermore, reporting cost based with industry CCS could be misleading (using numbers from open literature today are confusing at most) and should be noted that it is more complicated than the power sector. For example, the integrated nature of oil refineries, steel mills, pulp and paper - are too site specific that would make any numbers reported in literature regarding cost to be not comparable. Please refer to various documents from IEAGHG.	Noted. This paragraph no longer appears in Section 7.5.5. Page length limitations for Chapter 7 do not allow us to go into this level of detail.
29786	7	30	4		10	Additional literature (not only based on literature from academics) should be beneficial to this document. I will send these reports for your references. Some reference that could be referred to this text include [1] IEAGHG Report No. 2008-3 on Cement Industry, [2] IEAGHG Report No. 2013-4 on Iron and Steel Industry, [3] IEAGHG Technical Review No - 2013-TR3 on CCS for Ironmaking Process [4] Concawe Report on Oil Refining Sector	Noted. This paragraph no longer appears in Section 7.5.5. This material has been moved to Chapter 10.4 and the suggestion to include these fine IEAGHG reports has been passed along to the authors of that chapter.
33043	7	30	4	30	10	Refer to the broader discussion of CCS in industry in Chapter 10 here.	Accepted. This has been included in the revised Section 7.5.5
25941	7	30	40	31	1	...should last at least a century. Edmonds, et al., (2007)...	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements to Section 7.5.5 Moreover this sentence no longer appears in Chapter 7.
33045	7	30	45	31	5	This bottom up perspective of CCS technologies is very useful. To better inform the reader on how this information compares with the IAM results, it would be much more useful to cut these paragraphs to 7.11 and embed them in a broader discussion.	Accepted. The discussion of IAM related results has been removed from Section 7.5.5 almost completely. The only remaining references are used merely to help set up a more "bottom-up" engineering point/
24221	7	30	8	30	9	As the following Hayashi et al., 2012 is important for advanced research describing the performance improvement of CO2 capture in Steel mills, this should be added as a example: Steel Industries in Japan Achieve Most Efficient Energy Cut-off Chemical Absorption Process for Carbon Dioxide Capture from Blast Furnace Gas, GHGT11 proceeding (2012) available at: https://www4.eventsinteractive.com/iea/viewpdf.esp?id=270035&file=%5C%5CDCFILE01%5CEP11%24%5CEventwin%5CPool%5Coffice27%5Cdocs%5Cpdf%5Cghgt%2D11Final00114%2Epdf	Noted. This paragraph no longer appears in Section 7.5.5. This material has been moved to Chapter 10.4 and the suggestion to include these fine IEAGHG reports has been passed along to the authors of that chapter.
23611	7	30	9	30	9	After the sentence that ends with "Tsupari et al., 2012)", it is suggested to add a sentence to cite the following frequently-cited journal article which provides a comprehensive review on the performance of state-of-the-art research on CO2 capture technologies for key industrial processes: - Kuramochi T., A. Ramírez, W. Turkenburg, and A. Faaij (2012a). Comparative assessment of CO2 capture technologies for carbonintensive industrial processes. Progress in Energy and Combustion Science 38, 87–112. (DOI: 10.1016/j.pecs.2011.05.001).	Noted. This paragraph no longer appears in Section 7.5.5. This material has been moved to Chapter 10.4 and the suggestion to include these fine IEAGHG reports has been passed along to the authors of that chapter.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19623	7	30	1	30	22	In Latinamerica there are countries with T&D losses greater than 30 or 40% (fro example: Domenican Republic). Some paragraph about this situation should be mentioned in the report, because this is one of the difficulties to implement GHG reductions through DSM programme	Taken into account - comment seems to be misplaced.
20899	7	30	26	30	30	The examples given for storage capacity assessments are arbitrary and they should be characterized within the mentioned CO2 storage pyramid. Hence if the given examples are theoretical, effective, practical or matched capacity. # The source for the estimate for Norway is not provided (NPD 2011). # The GeoCapacity final report provides a conservative estimate of 117 Gt CO2 for Europe.The quoted publication provides only preliminary results. Cf. Vangkilde-Pedersen, T., Neele, F., Wojcicki, A., Le Nindre, Y.-M., Kirk, K., Anthonsen, K. L., … Smith, N. (2009). GeoCapacity: Final Report (No. D 42). Denmark: GEUS. # the assessment for China is very optimistic. From our research in China, it is much lower than the provided number (compare: Viebahn, P., Esken, A., Höller, S., & Vallentin, D. (2012). CCS Global - Prospects of Carbon Capture and Storage Technologies (CCS) in Emerging Economies (Final Report of Wuppertal Institute on Behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) (p. 550). Wuppertal. www.wupperinst.org/ccs , which is currently prepared for article publication) # there is no quote for the US results.	Accepted. This section has been shortened and simplified. Hopefully this address the concerns.
20900	7	30	34	30	49	The assessment by Dooley 2012 lacks a sound methodology and does not provide sufficient information to varify the assessed capacities. It seems very unlikely that the capacities in the USA are so much higher than in the other analysed regions. Hence it is too insecure to rely on the argumentation that there is sufficient global storage capacity availlable only on this analysis. The results of this study takes several paragraphs into account and it should be shortened.	Accepted. This section has been shortened and simplified. Hopefully this address the concerns.
24642	7	30	34	30	37	Figures sourced from Dooley 2012 appear to be incorrectly cited. Matched capacity should be 290 GtCO2 and theoretical capacity 35,300 GtCO2.	Accepted. This section has been shortened and simplified. Hopefully this addresses the concerns.
23925	7	30	4	30	7	I have looked at the work by D. Johanasson regarding the mitigation potential for refineries and see no practical application of mitigation potentials apart from what is know in the refining industry already. Many studies are referenced by her - UNIDO, IEA and so forth - none of which, of course, runs a refinery. Many possible opportunities are evident for improved efficiency, but it doesn't mean that the studies are practical to implement; for example, highly intergrated heat recovery processes can impact the availability of the plant and, if anything, can lead to increased emisssions from forced shutdowns and startups. Her study is full of assumptions about availability of CCS sites and technology availability. Generating hydrogen from biomass is pie-in-the sky and little does she understand about the difficulties of using biomass in FT technology. So, where does all this lead us. Really - no where. It would have been interesting had she studied the CO2 emissions saved by the shutdown of refineries in Europe over the recent decade; surely something to note! In any case, foremost in the refinery manager's mind is always how to reduce costs and one of the major ones is by improved fuel efficiency. I studies such projects in the early 1970s, even when oil was $3/barrel.	Noted. This passage no longer appears in Chapter 7.
24643	7	30	45	30	49	Figures sourced from Dooley 2012 appear to be incorrectly cited. Dooley notes for an end-of-century concentration of 350-399ppmv, the average demand for CO2 storage over the course of the century is 1670 GtCO2; for 400-499ppmv, avg. cumulative demand is 1340 GtCO2; for 500-599ppmv, avg. cumulative demand is 710 GtCO2; and for 600-725ppmv, avg. cumulative demand is 410 GtCO2.	Accepted. Thank you for pointing out the error here. It has been corrected.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21408	7	30	9	30	10	The CCS costs summarised in section 7.8.2 (Figure 7.10) may not be only for capture. Please confirm this.	Accepted. The text pointing readers to section 7.8.2 has been clarified and an additional reference to section 7.6.4 has been added as that is where the cost of CO2 transport via pipeline is discussed.
20482	7	31				CCS has high upfront cost, but definitely no low operation costs!	Accepted - Text amended to make it clear that variable costs of CCS could be high.
21823	7	31	1	31	5	The issue of option value (the value of a mitigation option in a portfolio) is an important one, and should be dealt with consistently for all mitigation options, not just CCS. In the CCS case, and particularly for 2oC scenarios, it is important to further draw out the heavy reliance on BECCS. A lot of work has now been done on restricted technology portfolio analysis (not least in the GEA), and this should be covered in more depth.	Noted. BECCS has been emphasized.
21140	7	31	1	31	24	Storage development?	Noted. The text has been revised. Comment is now obsolete.
36817	7	31	10	31	24	This introductory paragraph should explicitly note "reliability" requirements (alongside "balancing", "adequacy", "T&D" - covering all aspects of sufficiency). It should also identify integration challenges with intermittent AND/OR remote resources (the former is covered, but the latter is missing).	Accepted - text revised.
26816	7	31	12			Consider for inclusion- Infrastructure challenges are particularly acute for RE deployment in developing countries, often increasing the risk associated with RE investments and, in extreme cases, preventing a prospective project from being realized. "IRENA (2012), Financial Mechanisms and Investment Frameworks for Renewables in Developing Countries (pg. 19), http://www.irena.org/DocumentDownloads/Publications/IRENA%20report%20-%20Financial%20Mechanisms%20for%20Developing%20Countries.pdf"	Taken into account - the associated challenges are addressed in the policy section 7.12.
36818	7	31	14	31	14	Suggest simplifyling to say: "adequate generation capacity is installed to meet peak demand (resource adequacy) and ..."	Accepted - text revised.
19641	7	31	17	31	18	Add to the references: Huva, R., Dargaville, R. and Caine, S., 2012. Prototype large-scale renewable energy system optimisation for Victoria, Australia. Energy 41 (1), 326-334; Rasmussen, M.G., Andresen, G.B. and Greiner, M., 2013. Storage and balancing synergies in a fully or highly renewable pan-European power system. Energy Policy 51, 642-651;	Accepted - references added.
36819	7	31	21	31	24	While this statement is generally true, integration becomes less costly and easier to do as utilities and system operators gain experience. Case in point, in 2010 PacifiCorp estimated that the cost of integrating 2 GW of wind power was $9.60/MWh. In 2012, it estimated that the cost of integrating 2.1 GW of wind power was $1.89/MWh. As mitigation become more important over time there is a learning effect which should be mentioned.	Rejected - This comment is not supported by the report cited by the reviewer. The report authors state "The primary cause for the reduction [in integration costs] is lower forecasted natural gas and power market prices." Learning may have an effect, but many other factors may similarly make these costs different than current estimates.
24295	7	31	26	31	28	"thermal plants with CCS" should be used here to replace CCS. Meanwhile, from technical perspective, most RE technologies such as those for wind, solar and wave could not be base-load power sources.	Accepted - text revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
31534	7	31	26	31	28	"thermal plants with CCS" should be used here to replace CCS. Meanwhile, from technical perspective, most RE technologies such as those for wind, solar and wave could not be base-load power sources.	Accepted - text revised.
31661	7	31	26	31	26	It would be beneficial to open this sub-section by noting that matching electricity supply to demand is a fundamental requirement for a successful electricity supply system. This requires flexibility in the supply side (and in some circumstances also from the demand side). The ability of the supply side to deliver this flexibility is dependent on the individual technollogies and the combination of technologies. Then the rest of the section makes sense as it discusses the limitations on the flexibility of some technologies and techniques and technologies for mitigating these characteristics.	Rejected - since this is done on line 13.
33872	7	31	26	31	27	There is a lot of evidence that geothermal can provide both base-load and flexible power. Since geothermal plants generate power at high capacity factors, they require much less transmission capacity to deliver the same amount of energy when compared to other types of RE. Although using geothermal as a base-load operation is typical, geothermal plants can operate in a flexible mode. The lack of uniformity among geothermal plants is a strength because geothermal projects can provide the highest value of service tailored to the operating environment and operational needs of the customer. The report should also note that between nuclear, CCS, and geothermal, geothermal energy uses the least amount of water.	Rejected - The comment about water use is outside of the scope of this section. The text indicates the the primary reason geothermal is baseload is due to high upfront costs and low variable O&M costs. Even if it could be flexible, the most valuable operating mode is baseload until high penetration, at which point the text states that it will need to be operated in a flexible manner.
23292	7	31	26			Change "like geothermal" to "(except bioenergy)"	Rejected - only those technologies are mentioned which are characterized by low operation costs. Space constraints do not allow for mentioning (and exclude) all others.
36820	7	31	26	31	27	Please reconsider the conclusion that the operating costs of CCS are always low. Large costs are incurred and generally provide a driver for maximizing utilization - i.e., base load operation. Consider explaining that the costs of these technologies are driven by their "up-front" (capital) costs, with the increment associated with operating costs being significantly smaller than the increment associated with capital costs.	Accepted - Removed CCS from description of baseload technologies since its variable costs may be high, making part-load operation more frequent.
25711	7	31	3	31	5	This part should explain that there are only limited places where CCS is economical. Cost for CCS depends on a number of conditions such as concentration of CO2 in the exhaust gases, capture technology, access to storage site, storage potential, and CO2 monitoring, as described in (Finkenrath, 2011, page7), (Rubin, 2007, page4447, Table3), and (Lohwasser, 2012, Abstract). These literatures are listed in the No12 line of this table.	Rejected- This section is only about the infrastructure and systemic perspectives, the question of the economics of these different technologies is dealt with elsewhere (7.8.2).
36821	7	31	30	31	33	Does "part-load(ed) operation" mean partial capacity? Need to clarify. Also say "share of electricity demand" in France - it is not clear as written.	Rejected - this is standard terminology.
27064	7	31	32			The conclusions on nuclear's potential for part-load operation or load following are unclear. There is a reference to part-load operation in France. There seems to be a suggestion that it is possible (although it is not entirely clear). Could we have comments on nuclear plant operational flexibility substantiated by credible literature references? there is no serious evidence for this flexibility, then comments relating to the lack of flexibility of nuclear plant should be included since there will be operational costs to the power system due to this lack of load following.	Taken into account- additional references supporting the existing text are added.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36822	7	31	32	31	34	While true that part-load operation of nuclear plants is routine in France, the type of operation needed to deal with a potentially highly variable supply system (almost continual ramping of resources) is fundamentally different than current French practices, and may be challenging to achieve.--see Greenblatt, Long and Hannegan, 2012 (http://ccst.us/publications/2012/2012ccs.pdf)	Accepted - text revised.
33769	7	31	33			According to IEA's "Energy Policies of IEA Countries: France" (2009) 'In 2008, total generation reached 574.5 TWh of which close to 77% from nuclear power plants'. Therefore: … , where the share of nuclear is close to 80% of the annual demand.	Taken into account - the number is a detail which is omitted in the new text.
33770	7	31	34			… may be constrained by technical, economic, or institutional …	Rejected - as indicated in the same sentence there are examples of nations were it is done.
20721	7	31	34	31	35	Even pumped storage is currently employed on a very modest scale.	Rejected - the scale of pumped hydro is to be compared with other storage technologies, not with conventional power plants.
21825	7	31	37	31	46	Storage is a potentially major technological and infrastructural issue linked to RE intermittency and possibly warrants a dedicated section or at least, a clearer emphasis.	Taken into account - storages now play a larger role.
30542	7	31	37	31	37	The capital intensity of CHP and most other lw carbon technologies will tend to mean that they are always incentivised to run at high load factors. A bit of flexing in a CHP plant is neither very practical nor does it make that much of a difference.	Taken into account - text revised.
22550	7	31	39	31	42	Sentence is not correct. Both Storage hydro (ordinary storage or reservoirs based hydro) and pumped storage plants can be used for balancing or storing puposes - however ordinary storage hydro may be outfittet (or retrofitted) with a pump and then will be both types in one - suggestion: Sentence should read: "Reservoir (or storage) hydropower can be useful in balancing supply and demand due to the flexibility provided by the storage reservoir, as is increasingly being done by Norway. When the plant is outfitted or retrofitted with a pump it makes the storage even more flexible. A variant of this is Pumped Storage Hydro which is an energy store but not a source." - see also SRREN ch 5.3.2	Rejected - proposed text is too complicated and needs too much space. The new text, however, addresses the concerns.
36816	7	31	4	31	5	Expand on additional uses for CO2 streams from CCS - not just CO2-EOR (itself only briefly covered), but also potentially substantial demand from (and likelihood of system linkage to) fertilizer and food/beverage industries, among other emerging possibilities.	Rejected - Out of the scope of this section. This section identifies attributes that are important from a system integration perspective. Demand for CO2 streams in other industries is not appropriate here.
19770	7	31	42	31	46	There is no mention to CAES systems for energy storage. They are not anywhere close as popular as pumped storage but there large scale applications in operation.	Rejected - Text currently mentions Compressed Air Energy Storage as a technology that could be deployed at a large scale in the future (e.g. beyond the two operating CAES proejcts).
33771	7	31	42			… increasingly being done …	Taken into account - comment is obsolete as underlying text has been deleted.
21902	7	31	42	31	46	Energy storage, either in means of pumped storage or compressed air can be subsidised with reasonable subsidies as shown in recent literature (Zafirakis et al, 2013 at Applied Energy Journal). This would allow better utilisation of otherwise rejected wind power.	Rejected - policy aspects are not addressed by 7.6.1.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26614	7	31	42	31	46	This sentence should clarify that alternative uses of the reservoir can constrain operations or designs. In addtion storage hydropower (without the pumping) can also be used to store energy for future use. Hydropower reservoirs are routinely operated to slow down release of the water to "store" it for later use. This sentence could be revised as follows: "Environmental constraints and alternative uses of the reservoir for transport or irrigation can constrain operations and/or designs in many locations. Today, hydropower storage (with or without pumping) is the only storage technology deployed at a large scale, but other technologies including compressed air energy storage and batteries may possibly be deployed on a large scale in the future (BP Roberts and Sandberg, 2011)."	Rejected - space constraints do not allow to go into these details here.
20483	7	31	44		45	What is "large scale"?	Taken into account - text revised for facilitating understanding.
20484	7	31	44		46	Various market studies, e. Pike Navigant, IHS, etc predict that until 2022 more han 50GW of energy storage to the grid will realised. Multi MW battery storage systems were realised between 2011 and early 2013. This development is not reflected in the report.	Rejected - although the battery application number increases the size is not comparable with pumped hydro (where a single power plant can have a size of 1000 MW).
31662	7	31	44	31	46	The term 'large scale' is not defined in this context. Some electricity storage solutions although not available currently as individual large scale embodiments may nonetheless deliver a large scale effect by installation of multiple instances around a network. This may be more effective that a single large unit in dealing with the effects of the intermittancy of some RE technologies. So it's worth noting that large scale storage units are not the only option to be considered.	Accepted - text revised.
26796	7	31	44	31	46	Thermal storage (molten salts) seems to be promissing as well and is already developped comertial scale "Gemasolar". You can refer to the SRREN but also one of your authors Dra. Luisa Cabeza.	Rejected - adding thermal storage to this section would be confusing.
21826	7	31	46	31	47	It's odd to jump within a paragraph from storage to curtailment as system balancing responses. They do serve the same end, but the means are so different and with different system implications that a clearer narrative sequence would help.	Accepted - Moved sentence about curtailment and surplus energy to end of next paragraph (a paragraph that covers variable RE balancing needs).
31663	7	31	46	31	48	It should be mentioned that curtailment can have a severe advers impact on the economics of operating RE plants (mainly wind) or on the costs to distributors and customers if (if take or pay contracts are used).	Accepted - text revised.
19642	7	31	46	31	46	Add to the references: Pickard, W.F., Hansing, N.J. and Shen, A.Q., 2009a. Can large-scale advanced-adiabatic compressed air energy storage be justified economically in an age of sustainable energy? Journal of Renewable and Sustainable Energy 1 (3), 10 pp. Pickard, W.F., Shen, A.Q. and Hansing, N.J., 2009b. Parking the power: Strategies and physical limitations for bulk energy storage in supply-demand matching on a grid whose input power is provided by intermittent sources. Renewable & Sustainable Energy Reviews 13 (8), 1934-1945.	Accepted - text revised.
36823	7	31	46	32	2	The sentence about curtailing renewables seems better situated in the following paragraph. The paragraph in which it currently resides is confusing. it combines CHP, hydro, pumped hydro and some unspecified RE technologies in a discussion of both storage and curtailment. With this range of options and technologies it is difficult for the reader to keep this all straight - and each of these technology option/combinations are important to the evolution and operation of the energy system.	Accepted - Text revised to move curtailment of RE to next paragraph on variable RE balancing needs.
21824	7	31	8	35	30	Section 7.6 has lots of technical detail on infrastructural issues, but it needs more closely linking to mitigation / the mitigation options discussed previously. At present, it is a series of technical descriptions and issues but not clearly linked in to the chapter nor clearly related to recent trends (e.g., since AR4). As such, it could be significantly shortened.	Noted. Section has been revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
31246	7	31	31	44	31	I would delete the "pumped" as I regard reservoir hydro as a form of storage too when it is linked with intermittent renewables (water canbe held back when the wind blows, sotring potential energy that can later be converted to electricity when the wind is weaker).	Rejected - our text makes this already clear.
26859	7	31	23	31	24	The conclusion that RE is "expected to be most technically demanding and costly" is not substantiated by the subsequent text.	Accepted - Text was revised to clarify that variable RE increase balancing costs, contribute less to resource adequacy, and in cases of remote RE increase transmission costs (esp. due to low capacity factor). These three factors make integration of variable RE more technically demanding and costly than other mitigation options.
26860	7	31	26	31	27	The sentence seems to indicate that low OPEX and high CAPEX make CCS and nuclear and geothermal best suited for base load. An explanation as to why is lacking but necessary.	Taken into account - text revised.
26861	7	31	32	31	33	As worded, the text suggests that part-loading of nuclear is a solution as RE penetration increases. However, the costs of this mode of operation are not mentioned.	Accepted - a reference to 7.8.2 now is included, where integration costs are discussed.
26862	7	31	40	31	42	Pumped hydro gains in flexibility if it has 2 storage reservoirs. The sentence could be modified to take this into account "due to the flexibility provided by the one or two storage reservoirs".	Rejected - this would result in a rather complicated wording. It is sufficient to say that reservoir hydro provides flexibility and pimped hydro even more.
26863	7	31	46	32	1	Demand response is mentioned very briefly at the end of this section. It would require a little more prominence.	Accepted - text revised.
20901	7	31	1	31	5	The direct quote by Edmonds (2007) - seems rather old to estimate costs and storage potentials (as it is mentioned above the broad research having taken place after 2007 or so) -if it is still wanted to be used, it could be shortened to one sentence with the main outcomes.	Noted. This sentence no longer appears in Chapter 7.
29183	7	31	1	31	3	Reference to cost or cost benefit in this sentence is confusing when the paragraph has been talking about the size of storage required, could do with furrther explanation or redrafting.	Noted. This sentence no longer appears in Chapter 7.
20991	7	31		31		This section mentions the economic costs of operation base load technology part-load, but cites only literature on the technical challenges. Estimates of the economic cost of reducing average full load hours should be included, e.g. via Hirth (2012) Hirth, Lion (2012): “Integration Costs and the Value of Wind Power. Thoughts on a valuation framework for variable renewable electricity sources”, USAEE Working Paper 12-150. http://ssrn.com/abstract=2187632, submitted to Energy Policy; Ueckerdt, Falko, Lion Hirth, Gunnar Luderer & Ottmar Edenhofer (2013): “System LCOE: What are the costs of variable renewables?”, USAEE Working Paper 2200572. http://ssrn.com/abstract=2200572, submitted to Energy.	Taken into account - This is important, but is more relevant to the comparison of the different mitigation technologies in Section 7.8.2. The purpose of this section is not to evaluate the costs and benefits of each mitigation technology.
33046	7	31				It's unclear how the options presented for RE integration relate to what was presented in the SRREN. Why is the integration section of the SRREN not referenced?	Accepted - Additional references to SSREN (beyond existing references in this section) were added to the first paragraph of Section 7.6.1 to link the discussion of RE impacts to that more detailed review.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33047	7	31				Section leaves the reader wondering how the options for integrating RE may also apply to nuclear? CCS? Fuel-switching? What are the implications for integration of those mitigation options, if any? Focus on RE seems unbalanced.	Rejected - Balancing, adequacy, and transmission needs are all discussed for non RE technologies throughout this section.Cost for CCS infrastructure is discussed in 7.6..4.
23919	7	31	2 6	31	27	Operating and maintenance costs are surely not low for the mentioned technologies. What makes a generator most suitable for base load operation is that it is dependable and dispatchable.	Rejected - Being dependable and dispatchable is not what leads to baseload operation, it is rather the low operating costs. CCGTs are dependable and dispatchable, but they usually run as intermediate plants since their operating costs are higher than that of a coal plant. The reviewer, however, is right in saying that CCS does not result in low operation costs. Concerning this point, the text has been revised.
34780	7	31	26	31	27	Hydropower could provide based load as well as peak-load. My proposition is to include hydropower in the list as it is the cheapest and most mature RE technology "Nuclear, CCS, and RE technologies like hydropower and geothermal have relatively high up-front costs and low operating costs, making the technology most suited for base-load operation.". Reference to this could be found in the recent IRENA report published early 2013 "Renewable Power Generation Costs in 2012: An Overview"	Rejected -Not supported by literature. (Reservoir) Hydropower is limited by the storage capacity. It is usually dispatched in a way that provides power when it is most valuable, given the limited energy in storage. Baseload operation would deplete the reservoir too quickly.
23920	7	31	35	31	35	As there are no CCS plants, as explained earlier, what is the intent in this statement? When there is a generator with CCS appended, then the CCS section should have turndown characteristics to match the power generator operation. Theoretical studies by Cohen amount to theoretical studies only and are far removed from the practicality of operating a complex CO2 recovery system.	Rejected - Existing sentence simply states that flexible operation of CCS is active area of research. The reviewers comments do not contradict this statement.
34781	7	31	39	32	13	This paragraph is very good. It could be good however not to include only Norway in the scope but other European countries (there are limitec interconnections between Nordic countries and Continental Europe, and those interconnections are DC lines). I would like to mention, as far as I know, that Norway is not developing pumped hydro storage (or maybe in study. There is a JRC publication on evaluation of this potential to transform existing reservoirs to pumped hydro storage within Europe). Where does this statement come from? Source?	Accepted - reference to Norway is deleted.
34782	7	31	44	31	44	Proposition to remove the bracket "(pumped)" and have just "pumped hydropower storage", as pumped hydro storage is different thaan storage (ref. IPPC, SRREN ; IEA, hydropower roadmap ; etc.). I fully agree that hydro with reservoirs provide flexibility and lots of services to the power system, but pumped hydro storage is different than "normal" hydro storage: the first PHS is considered worldwide as a storage device (recent EU communication, USA statements, etc.) it represents 99% of storage worldwide.	Accepted - text revised.
34783	7	31	44	31	46	Decentralised storage devices should also be added in that paragraph to be accurate and relevant.	Accepted - added decentralised storage devises to list of technologies that may be deployed at large scale in the future.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20544	7	32	1	32	2	More emphasis needed on "Power to Methane" technologies using e.g. the Sabatier process to produce hydrogen from variable renewable electricity sources such as wind or solar at times of excess production then combinging it with CO2 to produce methane that can be piped into national gas grids, for use in electricity generation to backup renewables in times of deficit. This process is being implemented by Audi in 2013: see http://www.technologyreview.com/news/510066/audi-to-make-fuel-using-solar-power/. REF: See Sterner, M., et al (2010) Renewable (power to) methane: Storing renewables by linking power and gas grids; available at http://www.iwes.fraunhofer.de/. See also Wenzel, H. (2010) Breaking the Biomass Bottleneck of the Fossil Free Society, Concito report, Denmark, 34pp.	Rejected - This storage technology option is in a similar stage (if not even more of in the demonstration phase) to other storage technologies already mentioned, no need to go into further detail about each option.
36824	7	32	1	32	2	Electrochemical and/or thermal methane synthesis is a "far over the horizon" technology. Until efficient and reversible hydrocarbon electrochemistry is demonstrated at the laboratory scale, it is too early to talk about hydrocarbon synthesis. Reviewers felt that power-to-fuels and/or power-to-gas have very limited economic potential, given the relative economic competition from other zero-net-carbon fuel cycles.	Rejected - The text currently refers to uses for surplus power. Process for converting surplus power to heat or chemical energy does not need to be reversible (resulting gas or heat can be added to existing gas or heat networks).
26098	7	32	10			Just in case you are looking for a citation on this (albeit a self-citation): Green, R.J. and N. Vasilakos (2012) “Storing Wind for a Rainy Day: What kind of electricity does Denmark export?” The Energy Journal, vol. 33, no. 3 pp. 1-22 (estimates the cost of this balancing at between 4 and 8% of the value of the wind output)	Taken into account - comment is obsolete as underlying text has been deleted.
32807	7	32	11	32	12	Quantify modestly.	Accepted - text revised.
21827	7	32	14	32	20	This paragraph addresses some portfolio design criteria for mitigation options overall which is very helpful. There are undoubtedly trade-offs in some cases and synergies in others. It would be useful to synthesise these in the chapter.	Accepted -research on defining cost-effective portfolios now is mentioned.
19643	7	32	17	32	17	An emerging literature is discussing the question of inflexible baseload and Elliston et.a. (2012) have questioned the need to incorporate any constant baseload generation in a renewable system. Reference: Elliston, B., Diesendorf, M. and MacGill, I., 2012. Simulation of scenarios with 100% renewable electricity in the Australian National Electricity Market. Energy Policy 45 (1), 606-613.	Taken into account - the reference is already cited.
20545	7	32	19	32	20	Re flexible CCGTs for renewable backup, add ref to: GE Enegy (2010) Flexefficiency 50 Combined Cycle Power Plant. Available at http://www.ecoimagination.com/portfolio/flex-efficiency.	Rejected - This is only a company fact sheet about a new power plant, not a peer-reviewed study.
24645	7	32	26	32	35	This paragraph is well written and sets out an important concept - please keep if shortening the chapter	Noted.
21828	7	32	26	32	35	Lovins among others has argued that the assumed capacity value of large-scale plants is inflated as it fails to account for the longer-lasting consequences of unplanned shutdowns and maintenance (and only accounts for regular planned maintenance shutdowns).	Rejcted - the capacity value will nevertheless be high.
20485	7	32	27			Here the availability of cooling water for thermal power stations is missing. The worldwide average capacity factor of nuclear according to the IAEA was never above 80% (IAEA 2013).	Accepted - Text is modified to include adequate cooling water" ...as long as sufficient fuel and cooling water supply is available and required maintenance is scheduled outside of critical periods."
21141	7	32	27	32	27	90% is the average capacity credit for existing plant? Is this taking into account ageing?	Noted - it is for operational plant.
33772	7	32	29			… the correlation between generation availability …	Accepted - typo corrected.
26178	7	32	3	32	13	This is an important issue for balancing RE.	Noted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25712	7	32	3	32	13	This part should be kept in the final version report because it is important to explain the need for system balancing caused by variable RE resources. The higher planning reserve margin will result in more costly structure as a whole power system. This is because it is necessary to install additional equipments for power grid stabilization if variable power sources such as wind power or photovoltaic were installed into power grid, as described in (DeCarolis, 2006, page 395 and 403). This literature is listed in the No15 line of this table.	Rejected - Additional costs are already estimated in Section 7.8.2, higher planning reserve margin is discussed in the following section on Resource Adequacy.
23749	7	32	3	32	13	Only speaks about difficulties in balancing RE generation. What about synergisms like hydro+bioelectricity seasonal complementation.	Rejected - the discussion is about remaining fluctuations.
20722	7	32	30	32	35	Precise capacity 'credit' figures for individual wind energy developments in the UK are readily available (see Jefferson, IAEE Spring Bulletin, 2012, etc.)	Rejected - Article is about capacity factors of wind turbines in the UK (annual energy production, not contribution to Resource Adequacy).
25713	7	32	32	32	35	This part should explain that the need for system balancing caused by variable RE resources, as described in the section 7.6.1 (page 32, line 3). The higher planning reserve margin will result in more costly structure as a whole power system. This is because it is necessary to install additional equipments for power grid stabilization if variable power sources such as wind power or photovoltaic were installed into power grid, as described in (DeCarolis, 2006, page 395 and 403). This literature is listed in the No15 line of this table.	Rejected - Additional costs are already estimated in Section 7.8.2, higher planning reserve margin is discussed in the following section on Resource Adequacy.
21829	7	32	32	32	35	Effect on reserve margins of high penetration of RE depends on extent of correlation between RE resources (and inter-connections between grid systems). Evidence from the UK suggests inversely-correlated wind regimes from plants distributed throughout the company have lower requirements for back-up generation.	Rejected - Overall conclusion that wind has lower capacity credit than conventional generation would not change (capacity credit even with dispersed generation is likely to be lower than 40% for any substantial fraction of energy from wind).
24646	7	32	36	32	40	This paragraph is well written and sets out an important concept - please keep if shortening the chapter	Noted
20486	7	32	36			Energy storage costs are still substantial, but for some technologies, this is changing rapidly, e.g. batteries. This development should be included.	Accepted - this development is now mentioned.
36825	7	32	4	32	4	Under "system balancing" suggest that the authors mention that this puts a premium on energy storage technologies (pumped storage, flywheels, capacitors, etc. as well as conversion in batteries & CAES).	Accepted, though revised text indicates that this puts a premium on any flexible resource, not just storage (premium for flexible CTs, demand response, etc).
23293	7	32	40			Need to add comment on demand side management as a means of reducing costly energy storage.	Taken into account - demand response measures are discussed.
27065	7	32	41	33	20	The section on Transmission and distribution is misleading, if not technically incorrect. The section states that renewables "will often" (line 43, page 32); CCS "may" (line 1, page 33); and nuclear "may" (line 4, page 33) require additinal transmission. Whereas renewable energy technologies wil often NOT require additional transmission (most distributed generation is renewable, which the latter part of the section fails to point out), all nuclear and most CCS, I would imagine would need additional transmission. Offshore RE technologies, obviously requires new infrastructiure, but the term "will often" is misleading. Especially so, when the term "may" is used to descibe transmission needs of nuclear and CCS.	Taken into account - distinguish between transmission needs for large RE (line 42 page 32) vs. for distributed generation (which includes some RE) (lines 12-16 page 33). The transmission grid extension needs for CCS and nuclear are now discussed as well.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20723	7	32	42	32	48	As James Oswald and others have found, offshore wind energy may be plagued by intermittency across a very broad area, with simultaneous calm periods from the Bay of Biscay and Irish Sea to the Baltic. See paper in 'Energy Policy' 2007, etc.	Rejected - the discussion is about how to ensure reliable supply. It is not about the reasons for the expected fluctuations.
20546	7	32	43	32	44	Additional cost of CSP with thermal storage should be offset by better matching of output to demand, c.f. PV or wind without storage. Ref CSP Today (2013) "CSP's Role in the US Energy Mix". Available from www.csptoday.com/usa	Accepted in part -- text revised, but reference is not considered.
32808	7	32	45	32	48	References for planned strengthening of the transmission systems in the EU and Canada.	Taken into account - the specific examples are deleted.
20547	7	32	45	32	48	Should add Reference to European Supergrid and Desertec proposals. See http://mainstream-downloads.opendebate.co.uk/downloads/WG2_Roadmap_to_the_Supergrid_Technologies_2013_Final_v2.pdf. See also Czisch, G. (2011) Scenarios for a Future Electricity Supply, Institution of Engineering and technology, 580pp ; and Desertec Industrial Inititive (2012) '2050 Desert Power: Perspectives on a Sustainable Power System for EUMENA'. Downloadable from http://www.dii-eumena.com/fileadmin/Daten/Downloads/Desert%20Power%202050/dp2050_study_web.pdf	Taken into account - a peer-reviewed paper is cited as a substitute for the non-peer - reviewed paper given here.
26865	7	32	11	32	13	This sentence is contentious as total GHG reduction is still obtained by increased penetration of RE even where conventional power plants' ramping is increased.	Rejected - The comment does not contradict the existing text.
26866	7	32	17	32	18	Suggest rewording: "… if those plants cannot be operated in a flexible manner, additional flexibility is required …'	Noted - Specific suggestion was not followed, but sentences were clarified.
26864	7	32	3	32	5	The sentence seems excessively decretal. Suggest re-wording: "Variable RE resources, on the other hand, especially at high penetration may increase the need for system balancing, beyond what is required to meet variations in demand. However, existing generating resources can contribute to this additional flexibility.	Taken into account - the text has been improved.
26867	7	32	35	32	35	A possible solution to the low capacity credit is the sharing/exchanging of reserves between balancing areas.	Rejected - this would confuse the point being made.
34784	7	32	1	32	2	Pumped hydropower storage, in pumping mode consume energy. This is currently used to enable variable/intermittent renewable to generate power… this high flexibility, even if not yet monetised, is a key point of integration a large scale of RE in the current power systems thanks to pumped hydropower storage devices. My proposal is to add pumped hydropower storage in the sentence: "Another option is to translate surplus power to heat and hydrogen or methane (“power to heat” and “power to gas”, respectively). In addition it is also possible to transfer power to power using pumped hydropower storage in pumping mode"	Rejected - pumped hydro is already discussed elsewhere in detail.
24644	7	32	3	32	13	Suggest include the role that advanced forecasting systems can play in facilitating system balancing. "System operators use accurate forecasts to determine unit commitment and reserve requirements; this can minimize ramping requirements of fossil plants and the need for reserves—a cost savings" Citation: Cochran, J. Bird, L. Hetter, J. and Arent, D.J. (2012).Integrating Variable Renewable Energy in Electric Power Markets: Best Practices from International Experience. NREL, April 2012, Page 22 (http://www.nrel.gov/docs/fy12osti/53732.pdf)	Accepted - Added new sentence that indicates that the portion of the balancing requirements due to uncertainty can be minimized with forecasting, though even with good forecasting variability will still need to be managed.
23921	7	32	4	32	5	The statement beginning with, "Existing generation--," should be qualified by adding, "when the renewable generation is low, oherwise, additional fossil generation has to be added to provide the necessary flexibility". You subsequent statements qualifying the IEA assessment are definitely in order.	Accepted - Revised text to make it clear that existing generation contributes flexbility, but at high RE penetrations additional flexibility beyond what can be provided by existing sources might be needed.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21830	7	33	1	33	6	Nuclear and CCS are compared with respect to network infrastructure implications, but there is a major difference here in that CCS infrastructure basically does not exist (at scale) whereas nuclear infrastructure does. This point more broadly reflects the weighting given to CCS with the implication that knowledge on CCS is as robust as it is for the other mitigation options all of which DO exist at scale (RE, nuclear, fuel switching, grids, etc.).	Rejected- The sentence simply states that transmission may be required for CCS depending on the tradeoffs between transmission cost and pipeline cost. It does not state what the result of this tradeoff is since, as the reviewer indicates, there is no CCS infrastructure at scale to evaluate.
26818	7	33	11			Consider for inclusion- At the more local level, cities are emerging at the forefront of climate change mitigation efforts. As demand for energy services expands, the energy infrastructure on which cities depend will have to be expanded, upgraded or substituted. This allows other benefits such as energy security, climate change mitigation through deployment of RE (centralised and distributed), as well as other social benefits. “IRENA and ICLEI (2013), “Integrating Ambitious Renewable Energy Targets in City Planning – Malmo, Sweden”, Renewable Energy Policy in Cities – Selected Case Studies, http://www.irena.org/Publications/RE_Policy_Cities_CaseStudies/IRENA%20cities%20case%207%20Malmo.pdf'	Rejected - the integration challenge is seen in the transmission and distribution networks and this is discussed. The legal boundaries of city have no relevance for the technical challenges discussed in 7.6.1.
36828	7	33	12	33	12	Suggest that the authors consider more discussion of Distributed Generation (DG) as an important future development. See, e.g., GEA (2012).	Accepted - additional references concerning virtual power plants are added.
20306	7	33	17	33	20	A more extensive discussion of virtual power plants would be valuable here. Research activities are conducted under the 7th EU Framework program (eBadge) and there are already companies active in this field (e.g. CyberGrid)	Accepted - additional references concerning virtual power plants are added.
36829	7	33	17	33	20	This section would benefit from an expanded discussion of the challenges (and potential solutions) to introducing distributed generation (both renewable and non-renewable). Is the challenge that in the developed world, transfer of power from the distribution network to the transmission network is difficult (or impossible)? Are the challenges different in developing countries, where transmission networks do not yet exist?	Rejected - space constraints do not allow to go into such details here.
20548	7	33	18			Add reference re virtual power plants. See Nikonowicz, L. and Milowski, J. (2012) "Virtual Power Plants - general review: structure, application and optimisation" Journal of Power technologies, 92(3) 135-149	Taken into account - additional references were added.
21831	7	33	18			Virtual power plants should be defined.	Rejected - space constraints do not allow to go into the details here. The concept is well known, additional information can be found in the cited literature.
21832	7	33	19	33	20	The rejection of any discussion on smart grids because "it has not been defined in a non-ambiguous way" is staggering. A large-scale rollout of smart meters at the point of use has begun in many countries, as have investments into informated switching and distribution infrastructure. These are all well recognised elements of smart grids for which there are abundant definitions or conceptualisations along broadly similar lines. To dismiss in two lines a major potential trend in electricity infrastructure (consistent with mitigation objectives including distributed RE and electric transport) in two lines just seems bizarre, particularly when at times considerable detail in the chapter is given to technologies which do not yet exist and which are far more uncertain and ambiguous than the smart grid concept.	Accepted - smart grids are now discussed in a more pronounced way (including additional references).
21206	7	33	20			Term "SRREN" is used for first time in the chapter and should be defined / elaborated in the sentence.	Editorial

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
23603	7	33	20	33	20	This reason for not desribing the various concepts of smart grid is not very convincing.	Accepted - smart grids are now discussed in a more pronounced way (including additional references).
23294	7	33	20			Change IPCC reference to Sims et al, 2011. This section missing commentary on mini-grids in rural areas.	Accepted in part, the ref has been amended.
36830	7	33	20	33	20	Suggest that Chapter 7 address the smart grid concept, despite differences in "definition." Suggest and expanded discussion, here and/or in a dedicated new subsection, and with or without supplementary box, including the range of current perspectives and developments, and highlight large strides since AR4. Reference work by ISGAN.	Accepted - smart grids are now discussed in a more pronounced way (including addional references).
26782	7	33	21	33	46	Would it be a good idea to quantify the impacts heat networks could have on counties which do not usually use them? For example, the UK's domestic heat demand (space heating and hot water) is less than the heat wasted from thermal power stations in the UK. Waste heat from all UK power stations equate to 48.2mtoe, which is mostly waste heat. Source: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65897/5939-energy-flow-chart-2011.pdf (UK Department of Energy and Climate Change, 2012)	Noted. In reality the problem with CHPs and district heating systems are: need for strong heat load preferably across all year around. In case those conditions are not met the economics of district heating becomes less attractive comparing with individual or distributed heating.
33773	7	33	22			Please check spelling of footnote (e.g. 10.7 EJ)	Accepted
23295	7	33	23			Hard to believe that globally heat only boilers provide only a little more heat than heat from CHP. Does it include all boilers in buildings including dwellings. Few countries have district heating but CHP also provides industrial heat I realise. Think statement needs checking. Also district heating plants are not all CHP as is implied here.	Rejected. Boilers which are installed in dwellings are not covered by the section of district heating systems. References to data are presented in table 7.1
31664	7	33	29	33	29	The term "smart district heating networks" is used but this is not any more defined than the term "smart grids" which was not discussed int eh previous section. Some indication of the meaning of 'smart' in the context of this sentence is needed.	Taken into account - text revised.
25168	7	33	32	33	34	Recommend rewrite to exclude assumption of offset. Otherwise, citation of offset required here. See comment on Chapter 7 entitled: **Implicit assumption of renewable energy mitigation potential are not supported by recent empirical, behavioral, and macroeconomic analyses	Taken into account - text has been revised.
31665	7	33	33	33	34	This final sentence in this paragraph does not make sense.	Rejected. It was edited according other comments
33774	7	33	34			… would have been produced …	Accepted
36831	7	33	34	33	34	"been" instead of "seem"?	Accepted
32809	7	33	35	33	37	References needed for efficiencies and losses.	Rejected. There are referenced to the table 1, which has corresponding numbers and sources of data
21089	7	33	35	36		In line 35 the quoted efficiency figures should be clarified as relating to "heat only" boilers (CHP boilers have lower efficiencies of heat generation). I am also not sure why the word "only" is used to qualify the 83% figure which is almost certainly an over-estimate, not based on actual measurement. Even an efficient modern condensing boiler rarely achieves over 90% in practice, whatever its nominal efficiency, so the 95% is also a bit misleading. (In principle, the same comment applies to p 8 lines 35-39 but the context there is more general so the wording is less liable to mislead).	Accepted
33775	7	33	36			… possible to improve it to 90-95%, dependent on the heat source. About 10% of the globally generated heat for sale is lost ...	Accepted

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21090	7	33	36	37		I do not understand where the 6.6% figure comes from. The number in Table 7.1 itself is a bit higher, at 8% or so. More importantly, that figure relates to Losses. When you add the Industry Own Use figure (which presumably includes pumping) the total comes to over 20%. Given the measurement issues mentioned above, the 6.6% figure is misleadingly precise and misleadingly low - at least 20% of the heat produced (and probably more) does not reach the final user.	Noted. Corrected to 6.9%. Which is heat losses (0.89) divided by (CHP (5.86) and boilers heat generation (7.05) minus electricity plants own use (0.1))
25715	7	33	39	33	43	This part should include "heat pump technology" into future technology development because heat pump is a representative of high efficient water heater. Heat pump technology has huge potential to reduce GHG emission from building and industrial sectors, as described in (IEA/OECD, 2010, page6-83), (IEA, 2011, page16) and (UNIDO, page38, Fig14). These literatures are listed in the No17 line of this table.	Accepted
25381	7	33	4	33	6	Although location requirements of a nuclear plant may differ according to countries and areas, it should be added that stable bedrock is one of the basic requirements.	Rejected - unnecessary detail.
25714	7	33	4	33	6	This part should be deleted completely. In the survey described in (Jablon, 1991), it was reported that any genera association was not detected between residence in a county with a nuclear facility and death attributable to leukemia or, in fact, any other form of cancer. In addition, wind turbines are also installed far from load centers too <Reference> [1] Jablon, S., Z. Hrubec & J.D. Boice (1991). Cancer in Populations Living Near Nuclear Facilities. JAMA 265(11), pp. 1403-1408. Available at: http://www.iaea.org/Publications/Magazines/Bulletin/Bull332/33205892027.pdf	Rejected - no statement was made claiming risks, merely public perception of risks which is undeniable.
21833	7	33	43	33	46	These key conditions for more efficient district systems are important, but are difficult to interpret without the basics of district heat/coolth having been explained. Whether trends since AR4 or in the last 10 years are consistent with these efficiency conditions would also be useful to know.	Noted. Some trends are mentioned. At the beginning of the section. But there is no sufficient room to reflect basics of district heating in this small section.
31666	7	33	43	33	46	Physical efficiency' is an unusual term and it is not clear why it is used here. The term "triple generation" and needs explanation.	Accepted. Replaced with energy efficiency. There are energy efficiency and cost efficiency concepts. What may be energy efficient is not necessarily cost efficient. Triple generation has been replaced by tri-generation.
36826	7	33	7	33	11	Suggest the authors remove "since it is subject to planning consent" (l. 8). This is an ambiguous and unnecessary clause.	Accepted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36827	7	33	7	33	11	This paragraph alludes to, but fails to explain, the institutional issues affecting transmission and distribution (beyond visual intrusion). The three important omissions are cost allocation, risk management, and habitat protection. A major investment in transmission that connects new renewable and low-carbon electricity resources will have benefits besides climate change mitigation. These additional benefits can include better reliability and congestion relief. The benefits might not be spread evenly among those who pay, however, especially for transmission projects that extend over long distances. FERC has attempted to stimulate institutional evolution by directing regional transmission organizations and transmission owners to develop transparent cost allocation principles. But one outstanding question is whether costs should be socialized, allocated strictly on a beneficiary-pays basis, or on a hybrid of the two principles. Regarding risk management, major transmission investment often conflicts with the "used and useful" principle that has guided transmission investment in the past. Uncertainty about which specific generation projects will ultimately connect to the line creates risk that was not present in the past, when major transmission lines were developed and financed in conjunction with the major coal and nuclear plants that would fully use them. In some cases, addressing this institutional barrier has required legislation. (See State of Texas, Public Utilities Regulatory Act, Sec. 39.904, competitive renewable energy zones). Finally, the need to connect remote renewable resources has pulled together two activities - ”transmission planning and habitat protection” - that have little institutional experience working together. In the United States, the Western Governors' Association began a regional planning effort that specifically included environmental and wildlife organizations. (See US Dept of the Interior, US Dept of Agriculture, US Dept. of Energy, WGA, Memorandum of Understanding, June 15, 2009, http://www.westgov.org/component/docman/doc_download/1208-state-federal-...). Similar efforts have begun for the Eastern Interconnection.	Taken into account - the comment is obsolete as the underlying text has been deleted.
33048	7	33				Section is interesting, but fails to inform the reader about challenges (if any) for integrating the mitigation options presented in 7.5.	Rejected. Lines 28-34 are addressing this. There is no space to elaborate in more details.
29184	7	33	44	33	44	The term "triple generation" is not widely used, "tri-generation" is more common.	Accepted
23750	7	34	1	34	2	There are studies showing more than 10%. Probably more than the range quoted for unconventional oil, shale gas, and even for conventional NG.	Noted. Link to section 7.5.1.
20549	7	34	18	34	26	Add ref to "Power to Methane" technology - see my comment on page 32 above	Noted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
35380	7	34	18		20	Biomass and waste cannot be considered 'Low CO2 emitting natural gas substitutes', therefore I suggest deleting this reference. There is general global consensus that the climate benefits of waste avoidance and recycling far outweigh the benefits from any waste treatment technology, even where energy is recovered during the process. Although waste prevention is found at the top of the 'waste management hierarchy' it generally receives the least allocation of resources and effort. The informal waste sector makes a significant, but typically ignored, contribution to resource recovery and GHG savings in cities of developing nations. Reference: UNEP, 2010. Waste and climate change. Global trends and strategy framework. Specific comparison analysis about energy conservation potential in various treatments options have been carried out in Morris, J., 1996. Recycling versus incineration : an energy conservation analysis. Waste Management, 3894(95), which concludes that for 24 out of 25 solid waste materials, recycling saves more energy than is generated by incinerating mixed solid waste in an energy-from-waste facility. Recycling conserves energy that would otherwise be expended extracting virgin raw materials from the natural environment and transforming them to produce goods that can also be manufactured from recycled waste materials. Furthermore, energy conserved by recycling exceeds electricity generated by energy-from-waste incineration by much more than the additional energy necessary to collect recycled materials separately from mixed solid waste, process recycled materials into manufacturing feedstocks, and ship them to manufacturers, some of whom are located thousands of miles away.	Rejected. Biomass and waste are not being incinerated, they are being converted to a natural gas substitute.
35432	7	34	18		20	Biomass and waste cannot be considered 'Low CO2 emitting natural gas substitutes', therefore I suggest deleting this reference. There is general global consensus that the climate benefits of waste avoidance and recycling far outweigh the benefits from any waste treatment technology, even where energy is recovered during the process. Although waste prevention is found at the top of the 'waste management hierarchy' it generally receives the least allocation of resources and effort. The informal waste sector makes a significant, but typically ignored, contribution to resource recovery and GHG savings in cities of developing nations. Reference: UNEP, 2010. Waste and climate change. Global trends and strategy framework. Specific comparison analysis about energy conservation potential in various treatmnts options have been carried out in Morris, J., 1996. Recycling versus incineration : an energy conservation analysis. Waste Management, 3894(95), which concludes that for 24 out of 25 solid waste materials, recycling saves more energy than is generated by incinerating mixed solid waste in an energy-from-waste facility. Recycling conserves energy that would otherwise be expended extracting virgin raw materials from the natural environment and transforming them to produce goods that can also be manufactured from recycled waste materials. Furthermore, energy conserved by recycling exceeds electricity generated by energy-from-waste incineration by much more than the additional energy necessary to collect recycled materials separetly from mixed solid waste, process recycled materials into manufacturing feedstocks, and ship them to manufacturers, some of whom are located thousands of miles away.	Rejected. Biomass and waste are not being incinerated, they are being converted to a natural gas substitute.
21834	7	34	18	34	26	Some of the technical detail here is lost on me. What are low CO2 emitting natural gas substitutes? How can they be produced from fluctuating RE? How can CCS be added to production from RE - do you mean BECCS? Can gas substitutes be injected into the gas networks on a blended basis or does it have to be solely substitutes? Also, EC 2001 does not seem like an appropriate reference to support the claim that there are no technical barriers to injecting gas substitutes into the network.	Taken into account: The text has bee made clearer in the rewrite in respect of RE and gas substitutes (substitutes have been defined). A reference was cited for BECCS (Carbo et al) so no additional detail is needed here. Injection by definition means to blend, this is standard use. The reference (EC 2001) has been renamed Hagen et al.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36834	7	34	18	34	22	What is a natural gas substitute and why is it getting so much attention? Is there evidence that a future scenario under which a synthetic hydrocarbon (ie. methane or liquid fuel made from CO2 and NE or RE) will be cost- or emissions-competitive with alternatives (geologic natural gas, coal to gas, etc.) is a potentiality. Bio-methane is a low net carbon option, but that is simply bio-gas, and more appropriate to a different section.	Noted. Natural gas substitutes is a well known and used phrase, examples are provided. This section discusses the mitigation potential of gas networks. There is no space to give a detailed discussion on the economics of the processes. References provided give further details.
26940	7	34	18		20	Biomass and waste cannot be considered 'Low CO2 emitting natural gas substitutes', therefore I suggest deleting this reference. There is general global consensus that the climate benefits of waste avoidance and recycling far outweigh the benefits from any waste treatment technology, even where energy is recovered during the process. Although waste prevention is found at the top of the 'waste management hierarchy' it generally receives the least allocation of resources and effort. The informal waste sector makes a significant, but typically ignored, contribution to resource recovery and GHG savings in cities of developing nations. Reference: UNEP, 2010. Waste and climate change. Global trends and strategy framework. Specific comparison analysis about energy conservation potential in various treatmnts options have been carried out in Morris, J., 1996. Recycling versus incineration : an energy conservation analysis. Waste Management, 3894(95), which concludes that for 24 out of 25 solid waste materials, recycling saves more energy than is generated by incinerating mixed solid waste in an energy-from-waste facility. Recycling conserves energy that would otherwise be expended extracting virgin raw materials from the natural environment and transforming them to produce goods that can also be manufactured from recycled waste materials. Furthermore, energy conserved by recycling exceeds electricity generated by energy-from-waste incineration by much more than the additional energy necessary to collect recycled materials separetly from mixed solid waste, process recycled materials into manufacturing feedstocks, and ship them to manufacturers, some of whom are located thousands of miles away.	Rejected. Biomass and waste are not being incinerated, they are being converted to a natural gas substitute.
32810	7	34	19	34	19	Has "power to gas" been demonstrated? If so, does it represent a promising way to use excess electricity. Much like CCS, it's overall merit will be a function of its cost, efficiency of energy conversion, the process energy and associated emissions.	Noted: This section discusses the mitigation potential of gas networks. There is no space to give a detailed discussion on the economics of the processes. References provided give further details.
36835	7	34	19	34	44	It would be useful to briefly explain what is meant by the "power to gas" or "power to methane" ideas on this page	Accepted: The text has been reworded to provide a clearer description of the process ("…..(gases can be produced from surplus fluctuating electricity generation..")
32811	7	34	26	34	39	Quantify shorter delivery distances and higher flow rates, similarly the long distances for batch delivery.	Noted. The cited reference provides the detail.
23296	7	34	26			Again better to quote the specific IPCC chapter (8) as is referenced as Sims et al, 2011.	Noted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
29970	7	34	27	34	33	First, it might be possible for existing natural gas low-pressure networks to transport hydrogen instead of natural gas, particularly in those countries that use polyethylene rather than iron pipes (manufactured gas, which was widely used until the 1970s, contains 50% hydrogen). Existing high-pressure steel gas pipes cannot be used to transport hydrogen due to hydrogen embrittlement. Second, although the volumetric energy density of hydrogen is much lower than that of natural gas, hydrogen has a much faster flow rate so the energy flow is only reduced by around 20% relative to natural gas; in the context of most gas network operations, this is not "significantly reduced". For more details on both these points and further references, see: Dodds & Demoullin (in press) Conversion of the UK gas system to transport hydrogen. International Journal of Hydrogen Energy.	Noted. The referenced cited make clear the limits to H2 pipe transport
21835	7	34	27	34	28	Can H2 similarly be transported blended / in the same pipes as natural gas? i.e., switching costs of network infrastructure are very low.	Noted
21836	7	34	27	34	44	Hydrogen is another energy carrier (like heat and liquid fuel substitutes) which has not systematic introduction, no dedicated section, no clear contextualisation as a mitigation option within the energy sector. As a result, this paragprah is difficult to put in context.	Taken into consideration. This is the only place we have for H2.
21903	7	34	27	34	44	Hydrogen for transport is direct competition to battery-powered electric vehicles. Everything else equal it is not clear which technology is the best both in means of CO2 emissions and in means of costs	Noted. We are not discussing the merits of mode options, just the prospect of gas transport.
33049	7	34	27	34	44	Misses a discussion of what changes to the system would be necessary if higher percentages of e.g. hydrogen would be carried.	Noted. References cited made clear the changes needed.
20487	7	34	28		29	(Europen Commission 2004): This is not a European Commission Document but NaturalHy was an Integrated Project, co-financed by the European Commission through the Sixth Framework Programme (2002-2006) for research, technological development and demonstration (RTD). Therefore, it should be cited as (NaturalHy 2004).	Accepted
36832	7	34	3	34	5	"It has also been noted that future GHG mitigation from this sector will be limited by the increased energy requirements of extraction and processing of oil and gas from mature fields and unconventional sources, and the mining of coal from deeper mines." Suggest attaching "using current technologies" characterization. Suggest also providing citation(s).	Accepted.
36833	7	34	3	34	6	Suggest the authors insert a brief description of the sources of coal mine methane and emission trends here. There are more factors affecting GHG emissions than just energy requirements or underground mines going deeper.	Rejected. We do not have the space to do this.
25169	7	34	36	34	36	Hydrogen is not an energy source but an energy carrier and should not be compared to natural gas. In it's current form, this is equivelent to stating that electricity potential is greater than that of natural gas.	Rejected. We do not state that H2 is an energy source, rather that it has mitigation potential.
20550	7	34	43	34	44	Add ref to "Power to Methane" technology - see my comment on page 32 above	Accepted.
29185	7	34	43	34	44	Actually it is possible to produce many other gases than methane that can be injected into the gas feed via this route, so would suggest use "gaseous hydrocarbons" rather than "methane". This is normally done via hydrogen (produced by electrolysis) as an intermediate followed by the reaction of hydrogen with a carbon dioxide (usually from an industrial source such as output from breweries or cement works or by separating the CO2 from air or sea water) either by using a catalysis or, in some cases, using bacteria. One drawback of this approach is that this reaction is exothermic, so you lose some of the energy content in the hydrogen to produce the more easily transportable and easily store-able gaseous hydrocarbons. You may want to mention this trade off.	Rejected. The term natural gas substitute is used, we do not state that it is methane. We also state that the substitute can be made via a number of sources.
23922	7	34	21	34	26	This statement is very imprecise. What quality of gas quality standard is in question; there may be no technical barriers to injection into a pipeline, but there are technical barriers to usage of the final gas composition, as the injected gas is most likely being mixed with natural gas and, finally, biomethane is methane, but pipeline quality gas has more than methane in it.	Noted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32812	7	34	46	35	30	This section seems an unnecessary addition to the extensive discussion earlier on CCS. The relevant details could be used to augment the earlier discussion and the remainder omitted to save space.	Rejected - issues about CO2 transport and the associated risks has not been discussed in 7.5.5. As these themes are important, they cannot be deleted.
25469	7	35		111		The "forthcoming" references should be made more definitive.	Accepted - citation to become more firm as documents get closer to publication
29186	7	35	18	35	21	I think this misses the point a bit. The cost of transporting CO2 by pipeline is proportional to the length of the pipe. The cost of transporting by ship increases less rapidly than the distance, so at some point the ship always becomes the cheapest option. So in reality combining pipes and ships for offshore networks could provide a cost-effective and lower risk solutions, than using pipes alone, especially for early deployment. As part of its Zero Emission Platform work, the EU have published a document that neatly summarises this engineering compromise. It can be found here: www.sitechar-co2.eu/FileDownLoad.aspx?From=Faq&IdFile=317	Noted but not accepted due to space considerations.
33776	7	35	19			… are summarized at the end of …	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements
21837	7	35	19			This is another good example of a highly speculative and entirely model or assumption-based claim about CCS, which differs substantially from other claims made based on experience and evidence about other mitigation technologies.	Noted. It is not clear what this review comment was trying to communicate in terms of changes / improvements
20488	7	35	23			Solar panels don't have a limited lifetime, but a guranteed power output for 20 or 25 years. Various studies have been publish to this extend. See also Results of the European Commissions Solar test Installation: Artur Skoczek, Tony Sample, Ewan D. Dunlop, The results of performance measurements of field-aged crystalline silicon photovoltaic modules, Progress in Photovoltaics: Research and Applications, Volume 17, Issue 4, pages 227–240, June 2009	Noted.
21838	7	35	31	37	2	It's certainly important to consider cc impacts on the energy system, but the segue from the previous section is odd. The placement of this section disrupts the flow. It's also not clear the extent to which this section should consider the impacts of cc on demand (e.g., heating and cooling) as these are definitionally excluded from this chapter. (Of course, impacts on demand will feed back up into impacts on the energy supply, but the emphasis here should be firmly on the energy supply).	Rejected - Demand is addressed in Chapter 9.5 in more detail, and our first paragraph includes some demand discussion only because demand impacts supply. The majority of the section already focuses on supply. As for the location of the section, and challenging "flow" of the chapter, the authors agree, but have no authority to change the structure of the chapter, as it was agreed early on in an IPCC plenary.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21142	7	35	38	35	38	Develop the link between climate change and peak demand. Are you considering demand side response in this analysis?	Rejected - We do not have the space to address these issues comprehensively, but other chapters of AR5 address the climate-energy demand link in more detail than we are able to do in the energy supply chapter. We do not in our text here address demand response, but instead focus on the primary pathway of the possible impact of climate change to peak demand.
20992	7	35		37		To me, it seems that there is room to shorten subsection 7.7 The statements made here are rather generic; the text includes a direct citation of a full paragraph	Rejected - Section text has already, in the past, been reduced significantly. The text that remains fits the page budget allocated.
20307	7	35	31			The section climate change feedback and interaction with adaptation could mention, that stronger impacs may result from impacts and adaptation and mitigation measures in demand side sectors, even if not dealt with in detail here.	Rejected - This suggestion has been addressed in a few sentences in this Chapter (e.g., the interdependencies discussion), but most demand side issues are handled in chapter 9.5 as that is the chapter in which energy demand impacts are mentioned (as well as in the IPCC WGII report).
25470	7	36		36		"Power generation facilities and energy delivery infrastructures may also experience performance losses and other impacts due to changes in the access to and temperature of cooling water, as well as sea level rise and extreme weather events (D Arent et al., Forthcoming; Kopytko and Perkins, 2011; Roberto Schaeffer et al., 2012)." - energy delivery infrastructures do not experience performance loss due to access to or temperature of cooling water	Accepted - we have revised the text to state: "Some power generation facilities will also be impacted by changes in the access to and temperature of cooling water, while both power generation facilities and energy delivery infrastructures can be impacted by sea level rise and extreme weather events. (D Arent et al., Forthcoming; Sathaye et al., 2013; Kopytko and Perkins, 2011; Roberto Schaeffer et al., 2012)." Also, note that Sathaye et al. 2013 has been added. USDOE is also about to publish a major report on impacts to energy infrastructure: this work has also now been included in the citations.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25165	7	36				Recommend significant rewrite to exclude RE as mitigation stratagy. See comment on Chapter 7 entitled: **Implicit assumption of renewable energy mitigation potential are not supported by recent empirical, behavioral, and macroeconomic analyses	Rejected - not sure how this comment impacts section 7.7 specifically, but see earlier response to overall concern of the commenter.
21207	7	36	11			Provide space i.e. "evolve. For"	Rejected - not applicable to page 36, line 11
21143	7	36	18	36	22	Link between hydro availability and snow. Important in Norway, Switzerland where inputs to hydro reservoir are highly dependant on melting snow rates	Rejected - This section is intended to be a quick summary; more details are found in the WGII AR5 report. We also believe that the link between hydro availability and snow is generally captured in the sentence: "….results also indicate the possibility of substantial variations across regions and even within countries…."
33874	7	36	21	36	25	Please elaborate- how will climate change not have a significant impact on size or geographic distribution of geothermal energy? Intuitively, changes in precipitation pattern may affect water availability and make water use rights a critical barrier. If true, such a statement warrants a citation.	Rejected - space constraints preclude providing more details here, but the bottom line is that precipitation patterns are unlikely to fundamentally alter the underlying geothermal energy RESOURCE, and this paragraph focuses on resource issues. Two paragraphs down we note that water availability might also impact power generation facilities, so this link between water and energy facilities is already addressed later in the text.
32813	7	36	23	36	23	All technologies have limited lifetimes.	Accepted - We have changed this paragraph to start with: "A decline in renewable resource potential in one area could lead to a shift in the location of electricity generation technologies over time to areas where the resource has not degraded. Long-lived transmission....."

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20489	7	36	23			Solar panels don't have a limited lifetime, but a guranteed power output for 20 or 25 years. Various studies have been publish to this extend. See also Results of the European Commissions Solar test Installation: Artur Skoczek, Tony Sample, Ewan D. Dunlop, The results of performance measurements of field-aged crystalline silicon photovoltaic modules, Progress in Photovoltaics: Research and Applications, Volume 17, Issue 4, pages 227–240, June 2009	Accepted - We have changed this paragraph to start with: "A decline in renewable resource potential in one area could lead to a shift in the location of electricity generation technologies over time to areas where the resource has not degraded. Long-lived transmission....."
21839	7	36	23	36	30	Is the wind and solar resource really expected to meaningfully degrade in terms of power output over the coming century to the point where infrastructure may be re-sited?	Accepted - sentence has been revised to clarify (actually, to make the point more generally). Details specific to wind and solar cannot be provided in this short, space-constrained section, but the SRREN and other documents provide evidence of the scale of possible resource decline.
36836	7	36	23	36	24	Suggest deleting the first sentence. First, nothing lasts forever. The fact that a wind turbine has a 20 year design life and a coal plant a 50 year design life says little about whether either will still be operating in 50 years (a wind plant may repower with new turbines, just as a coal plant may refurbish its boiler or replace its generators). Second, "more adaptable to such changes" than what? Hydropower, maybe. Wind and solar parks involve serious investment in balance-of-station capital. It is cheaper to re-power an existing site as wind turbines age, for example, than it is to build a new greenfield wind farm. If the resource in a particular location changes significantly, there will be major stranded assets. Further, one would think that given their total dependence on the resources where they are, renewables such as hydropower, wind and solar would be more vulnerable to changes in that resource than many other energy technologies. Changes in climate may cause scarcity of fuelstocks for biomass power plants or increase fuel transport costs, but one cannot transport wind or sunshine at all.	Accepted - We have changed this paragraph to start with: "A decline in renewable resource potential in one area could lead to a shift in the location of electricity generation technologies over time to areas where the resource has not degraded. Long-lived transmission and other infrastructure....."
36837	7	36	23	36	25	It is not clear that with reasonable technology advance, that RE assets will be much shorter lived than their FE counterparts. Eg. even though PV module efficiency declines with age, it is not economic to replace a module until ~50 years.	Accepted - We have changed this paragraph to start with: "A decline in renewable resource potential in one area could lead to a shift in the location of electricity generation technologies over time to areas where the resource has not degraded. Long-lived transmission and other infrastructure....."

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19570	7	36	27	36	30	A view on hydroelectricity as an opportunity has been severily challenged by recent scholarship. In addition to their ecological impacts, now a set of other impacts to local and Indigenous peoples has been documented, including linguistic, economic, cultural and social impacts. Please refer for example to the ten-year study of Lokka and Porttipahta reservoirs and impacts to the local and Indigenous communities in Finland. Reference: Mustonen, Tero, Mustonen, Kaisu, Aikio, Antti ja Aikio, Pekka 2010. Drowning Reindeer, Drowning Homes – Indigenous Sámi and Hydroelectricity in Sompio, Finland. Osuuskunta Lumimuutos: Kontiolahti.	Rejected - This comment does not really relate to the text of section 7.7. Line 48 on page 36, however, generally describes how climate impacts on hydro systems may be positive or negative "depending on whether the potential climate adaptation benefits of hydropower facilities are realized". The more general issues / concerns associated with hydroelectricity are addressed elsewhere in the chapter, not in this section, so this comment may be better placed in those sections.
22551	7	36	29	36	30	ref also IPCC 2011a, ch 5.10	Accepted - Citation added
21904	7	36	31	36	42	Climate Change can threat most of the existing power and primary energy production systems in many different ways.	Noted - We believe this point has been made throughout the text in this section.
21840	7	36	40	36	42	2-3 lines on adaptation only: either delete, or expand into a sub-section on adaptive responses to all cc impacts. As is, it stands out for its brevity.	Rejected - severe space constrains limit us in this section. Issues of adaptation are better covered in the IPCC WGII report, and readers are directed to that report in the text. However, we opt to keep the sentences if only to make it clear that adaptation strategies do exist.
33777	7	36	7			Please add after … Roberto Schaeffer et al, 2012): Rademaekers et al, 2010. K. Rademaekers et al (2010): Investment needs for future adaptation measures for EU nuclear power plants and other energy generation technologies due to effects of climate change. Ecorys, ECN, NRG, the Netherlands, 10 December 2010.	Rejected - Though a good reference, this appears to be gray literature, and is not essential to make the points that are critical to this section.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26868	7	36	31	36	33	It would be good to specifiy some of the extreme conditions considered as, for example, standards for offshore wind farms already take rising water levels and increased loads from waves into account.	Rejected - These details are better left to other chapters of AR5, including WGII, as this section can only afford (due to space constraints) to be a high level summary. Regardless, we note that the current text only discuss vulnerability - as the commenter suggests, some of this vulnerability has already been addressed through design standards, while other aspects may need new design standards (we do not have the space to be able to address these details, however).
23693	7	36	23	36	26	This part require a better explication	Accepted - This sentence has been changed based on a number of reviewer comments.
26046	7	36	31	36	33	This sentence is distorting the context in which Canadell, et.at, 2009 presented in original on Africa's emissions. The context and meaning will be complete if part of the paragraph left out is added to the text. The original Canadell,et.al 2009 text reads as follows:" Anthropogenic CO2 emissions of 0.5 Pg C yr−1 (500 Tg C y−1) in Africa are the smallest of all inhabited continents butnot insignificant compared to global emissions of 8 Pg C yr−1. The rate of growth in emissions, however, is above the world average, and Africa's share of global emissions is likely to increase in the coming decades".	Taken into account - comment seems to be misplaced.
32818	7	37		37		References for the data shown here. What do the boxes and error bars represent?	Taken into account. Caption updated.
20902	7	37		37		The chart for" natural gas CCS" is incorrect. In the text a range of 120-170 gCO2e/kWh for gas power with CCS is given.	Rejected. Please note that the text states that the cited value, as identified in the literature, is no longer valid because fugitive emissions are higher.
19067	7	37				Woody and other biomass missing from this figure!	Accepted. Added to chart and text.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
22552	7	37				This figure is not well explained and seems both misleading and confusing. In the SRREN fig 9.8 the same comparision is done (more or less) and it was there demonstrated that fossils with CCS emit more than the RE's, as in this figure . However, to my knowledge no plant scale CCS has been buildt on any fossil plant - therefore the figure is highly hypothetical and this aspect should be explained - also I find no good explanation of the graphs for the years 2010 and 2050, only an assumption of improvement over time - where are the data on fossil plants equiped with CCS in 2010? (Could the presentation from the SRREN be used (fig 9.8) ?) For hydropower the ranges are high and also here misleading. The figure text state that "biogenic emissions from hydropower are not included" - however, the only way to interpret the graph is that biogenic emissions in fact are included. Also - to be in line with the text coming later on page 38 it should be stated that the picture given is based on tentative ranges of gross emissions - (I presume this is true for the total graph) - based on the very high numbers of reservoirs in the world, poor statistics based on few sites and that there still are no consensusbased method for estimating/calculating emissions from flooded land/reservoirs (this is presently being adressed in the work of the IPCC Task Force/inventory guidelines) the high ranges shown are uncertain - this should be made clear in the figure text - the figure need editing or considered not to be shown ..	Taken into account. The figure has been updated. The fact that CCS does not exist in large scale is no reason to leave it out here; it is foreseen to play an important role (Ch.7 and 7.11) and credible engineering studies exist. The graph necessarily reflects the state of the literature.
33007	7	37				It would be useful to include a comparison with fossil fuels (esp. coal and gas without CCS) in this figure as a reference point.	Accepted. We now show emissions of a wider set of technologies.
33008	7	37				Please indicate the source of the data.	Accepted. Added to caption.
33067	7	37				The values in this figure differ from the SRREN values. Where this is the case, it would be useful to explain in the text why they differ, i.e. what has changed since the publication of the SRREN to account for this difference.	Rejected. Sources of the data are provided in the text; the revisions are based on an assessment of the literature.
33068	7	37				It may be more useful to restrict LCA values to 2010 values. The 2050 figures aren't necessarily meaningful, and introduce ambiguity into the figure.	Accepted
23298	7	37				No reference given. And again, have to be careful when interpreting LCAs unless know all the assumptions made. We made this very clear in Chapter 8 - for example Fig 8.3.2 and the related text. Maybe should add some disclaimer here.	Taken into account. Please note that we have full control over the LCA data and the assumptions made.
24222	7	37				Values gCO2e/kWh for Coal-CCS and Natural gas CCS are rather high compared to those in Table TS.3 of IPCC SRCCS 2005.	Taken into account. This is correct. The figure is based on new research.
22600	7	37				Change the scale of the graph - as the amjority of the technology are below 50gCO2/kWh	Rejected. Differences in the 10 g range are less important to show than those between fossil and renewable/nuclear.
21842	7	37	0			Include gCO2/kWh for all technologies to allow comparability.	Rejected. Not clear what is meant by the comment. gCO2e/kWh are shown on the figure.
33051	7	37	12			Why the focus on electricity generation? Please clarify in text. It would at least be useful to include heat generation costs. Transport costs would be covered in Chapter 8, so that discussion could be referenced.	Rejected. Electricity production accounts for 80% or so of emissions in the energy supply sector, which is the rationale for focusing on these. There is unfortunately not enough space for a discussion of heat and refining.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32814	7	37	14	37	15	It is useful to include the full range of GHG intensity values for electricity generated from coal. A footnote or further explanation of the use of the interquartile range would be appropriate.	Rejected. Please note that the SRREN included all studies found in the literature for their ranges, without excluding studies of questionable quality or irrelevant cases. The SRREN overview gives an idea of what is going on but for most technologies, the extremes are not meaningful.
36842	7	37	14	38	2	It is unclear whether the emissions factor for coal mine methane emissions is included in the coal production sector analysis.	Taken into account. Please note these emission factors are included also in 7.5.1
32815	7	37	15	37	17	Quantify “slightly better” and “significant reductions” in the context of oil-fired and natural gas plants.	Accepted.
23742	7	37	17	37	18	Mehane leakage is not a recent concern. See literature.	Rejected. The commentator does not provide any literature that would support the assertion
32816	7	37	18	37	20	Quantify “moderate emissions reductions”	Accepted.
23743	7	37	18	37	19	I understand that combined heat, cooling and power can make significant contribution for emissions reduction. See previous IPCC reports.	Rejected. Electricity production accounts for 80% or so of emissions in the energy supply sector, which is the rationale for focusing on these. There is unfortunately not enough space for a discussion of heat and refining.
25382	7	37	20	37	24	Suitable sites for renewable energy or CCS are eccentrically-located and installation of them requires great cost. It should be added that there are difficulties to make the world's average emission factor of electricity to zero.	Noted.
25717	7	37	20	37	24	This part should explain unlimited evaluation results because it is prejudicial and misleading to put an emphasis on limited scenarios of 2℃. IPCC should be policy-neutral and should have responsibility to indicate unlimited evaluation results, as described in Table 6.1. The 2℃ target is extremely difficult to attain, as described in (Höhne, 2011, conclusion) and (Rogelj, 2011, abstract). These literatures are listed in the No4 line of this table.	Accepted. The text has been reformulated to clearly indicate that there is a policy choice.
36843	7	37	20	37	21	Sentence pegs an emissions intensity target (line 21) to "average emissions" (line 20). Suggestion to insert "intensity" on line 20, or convert the number to its equivalent in absolute emissions.	Accepted. Editorial change made
36844	7	37	21	37	21	Perhaps more precise to say that 2 deg C expresses a climate goal - outcome of mitigation, rather than a mitigation activity per se.	Editorial
20724	7	37	25	37	32	This Figure is grossly misleading. The dispersion of results whether in 2010 or forward to 2050 will in part be dependent upon location, and threfore potentislly very wide.	Rejected. It makes no sense to show the likely emissions related to nonsensical and uneconomic projects. Yes, you can mount PV solar cells on a northward facing wall in Siberia. The presented ranges take some regional variability into account, but at the same time assume that decent conditions persist.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21905	7	37	25	37	32	Embedded carbon is a significant (if not the only) carbon emitting segment of renewable energy systems. Currently there is no assessment over that issue when promoting renewable energy.	Rejected. Embedded carbon is taken into account in the LCA results shown here.
23297	7	37	25			For LCA should cross-reference the Annex and also comment on the limitations of LCA.	Accepted - Annex section is referred to at the beginning of the section.
32817	7	37	26	37	28	Is there evidence to support this claim?	Taken into account. Please note that this claim was deleted in favor of a discussion of more technologies
36845	7	37	26	37	28	It is unclear what is meant here. Which technologies? For electricity generation? Or all manufacturing technologies? Please clarify.	Accepted. Sentence clarified.
23744	7	37	28	37	32	Why biomass based power generation is not included in the Figure??	Accepted. Biomass has been added to the figure and discussion.
26908	7	37	29			This graph is perhaps the most important graph of the entire Energy chapter, and yet it is severely undermined by not portraying the life cycle GHG emissions of conventional generation technologies. Does CSP or PV present significant life cycle GHG emissions reductions compared to coal or gas? This question is impossible to answer by looking at this graph, because life cycle GHG emissions for coal and gas (non-CCS) are not include. This failure severely undermines the usefulness of this graph - lifecycle GHG emissions of non-CCS coal and gas (GTs, CTs, and CCGTs) must be included. I would also note that for this figure, the more citations the better, as researchers will frequently refer to this graph over the coming years for estimates of lifecycle GHG emissions, and knowing these estimates are based on a wealth of studies would be preferable. (I understand that at least 5 studies are reviewed for each technology presented in that figure, but I would be even happier with 10 or 20 for each technology if possible. And I think those additional studies would be immensely helpful to researchers in the coming years.)	Accepted. We now show emissions of wider set of technologies. Please note that a difference in emissions intensity per kWh should not automatically be interpreted as emission reductions, as several other review comments have pointed out. There are two issues: whether the kWh are really functionally equivalent (do they meet the same demand; timing and location of supply) and market-mediated effects that say that if you don't burn the available gas, somebody else will.
29329	7	37	29			This graph is very important. To put these numbers in context, It should include life cycle GHG emissions of conventional generation technologies (coal, gas).	Accepted. We now show emissions of wider set of technologies.See comment 33007
21843	7	37	29			Why is gCO2/kWh higher from natural gas than from coal? (on a lifecycle basis). See also page 38, line 3, which has lower gCO2/kWh for gas.	Rejected. Please note that the text states that the cited value, as identified in the literature, is no longer valid because fugitive emissions are higher.
26615	7	37	29	38	2	Figure TS.19 is very confusing and misleading. Firstly, CCS is not a viable technology at this point in time. While there are demonstration projects, there is no evidence that this can or will be deployed at any scale relevant to emissions reductions. Secondly, the figure explanatory text notes that biogenic emissions for hydropower are not included, however the ranges provided indicate that they must be included. In addition, the full range of literature is not addressed. For example, Chanudet et al (2011) shows that hydropower reservoirs can be an emissions sink, which is not reflected in the figure.	Taken into account. The figure will be replaced. CCS will be kept, however, as it is a credible technology of interest.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20803	7	37	29	37		ADD. Please add a paragraph of "the renewable energy by subsidies"debates. In many countries, there are many heated debates over "the renewable energy by subsidies ". However, there are no paragraphs of these in this chapter 7. For example, there are many themes of energy cost-up by FIT(feed-in tariff), innovation barriers, associated back-up costs, etc. Please refer the following reference. <Reference> [1]Mitsutsune Yamaguchi et al. "Climate Change Mitigation A Balanced Approach to Climate Change". Springer. ISBN: 978-1-4471-4227-0 (Print) 978-1-4471-4228-7 (Online) . Please refer chapter 5 (cost of mitigation), and chapter 7(policies and measures).	Rejected. This issue is not relevant here.
36838	7	37	3	43	8	Section (7.8) and subsection (7.8.1, 7.8.2, 7.8.3) titles could more clearly reflect underlying technology focus. Suggest that (i) section title express "mitigation technology" upfront (paralleling related section 7.5 title on "mitigation technology options"), and (ii) subsection titles correspondingly remove vague reference to technology as "mitigation measures." Possible re-titlings: 7.8 "Mitigation technology costs and potential" 7.8.1 "Abatement potential" 7.8.2 "Cost characteristics" 7.8.3. "Economic potential"	Rejected - the title of the section cannot be changed any more at this late stage of the process. As this is the case, the subsections should retain the expression "of mitigation measures" for clarity.
36846	7	37	30			Please add citations to figure caption, so that numbers are clearly sourced. Citations appear in ensuing text, but should be explicitly attached to the figure.	Accepted. Figure to be revised and more extensively supported.
36847	7	37	30			Would help to add a fossil source w/o CCS for scale.	Accepted. We now show emissions of wider set of technologies.
33050	7	37	5	37	9	It is unnecessary to present mitigation options here AGAIN. Why not simply refer to Section 7.5? This would save space and assure consistency.	Accepted.
36839	7	37	5	37	7	Sentence is internally inconsistent: Consider removing "soil carbon management" (line 7) - this is agriculture/land use, rather than "energy sector" (line 6), mitigation.	Accepted. Entire sentence removed.
27768	7	37	5	37	9	This sentence implies that efficient energy use and the shift from carbon intensive energy sources are two different opportunities, but they are strongly related. Any energy supply is based on processes which also use energy. In countries with cold seasons energy efficiency will reduce the need of a great amount of energy facilities. Therefore energy efficiency is always the first step to reduce the remaining need for power plants.	Taken into account. Please note that the sentence was removed.
25716	7	37	7	37	9	This part should be revised to explain that it is important to use coal power efficiently from a viewpoint of energy security and economic efficiency. IGCC (Integrated Gasification Combined Cycle) technology is developing and has potential to reduce CO2 emission in the future, as described in (IEA, 2011, page7, page42 Fig14) and (Janos, 2009, page5, page7 Figure1 and Table 1). These literatures are listed in the No10 line of this table.	Taken into account. This issue is addressed in section 7.5.1.
21841	7	37	7			Is albedo and soil carbon management an energy sector option?	Accepted. Entire sentence removed.
23741	7	37	7	37	9	"the most significant opportunity, however, is a shift in energy supply away from unmitigated fossil energy sources, particularly coal". This statement is not accepted everywhere. There is literature claiming energy efficiency improvement is the major option.	Rejected. Please consult section 7.11
32462	7	37	7	37	9	It is more realistic and more productive to consider how to improve the efficiency of coal fired power plant than to simply encourage a shift in fuels. Therefore, the sentence should be rewritten or deleted.	Rejected. Please consult section 7.11
36840	7	37	8	37	8	Suggest replacing "unmitigated" with "GHG-intensive."	Editorial.
36841	7	37	9	37	9	Consider removing "the contribution of." It suggests a measurement of reductions already realized, rather than potentially realizeable.	Accepted

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
27066	7	37	16	37	17	Delete "Modern natural gas combined cycle plants bring significant reductions in CO2 emissions." A scientific report cannot state that a fossil fuel that is one of the laregst contributers to CO2 emissions reduces CO2. It is partly and directly responsible for the problem. Write how much it emits per kWh (as it is done for coal in the same paragraph). That can then easily be compared with the figure of 100g CO2 per kWh that is needed on average in the global power sector by 2050, which is refernce later in the paragraph.	Taken into account. Language to be changed.
26776	7	37	3			With the latest release of the EcoInvent database on the 6th May 2013 (version 3), LCA considerations in this document should be revisited to check against the latest available data. As it will be released after the deadline fo this review I do not know if there will be any inconsistancies with the SOD.	Rejected. Data released after IPCC deadlines in non-journal type literatures is difficult to include given the advanced status of this process; especially given that the documentation for EcoInvent on these issues has not been updated.
27067	7	37				Add values for coal and gas without CCS (the two largest power technoologies) to the figure. If there is a problem with the scaling due to the large difference between, e.g. nuclear and coal, ad a data table. It seems odd to compare the established RE technologies with coal CCS and gas CCS. As stated elsewhere in this chapter, the CCS technology is not relevant in the medium term. What is more relevant is how much the largest technologies emit, compared to the 100g CO2 / kWh needed in the power sector.	Accepted. Figure has been extended to include coal and gas.
25170	7	37				Recommend rewrite to exclude assumption of offset. Otherwise, citation of offset required here. See comment on Chapter 7 entitled: **Implicit assumption of renewable energy mitigation potential are not supported by recent empirical, behavioral, and macroeconomic analyses	Taken into account. Please note that we changed the opening in response to other review comments so that this comment is no longer relevant.
24296	7	37	15	37	16	The oil is mainly used in the transport(cf. figure 7.1). The oil fired steam power plants are very small(EIA energy outlook 2012) The statement should be deleted.	Accepted, oil has been removed. Note, however, that it is still important in Africa, Middle East, and Mediterranean countries.
31535	7	37	15	37	16	The oil is mainly used in the transport(cf. figure 7.1). The oil fired steam power plants are very small(EIA energy outlook 2012) The statement should be deleted.	Accepted, oil has been removed. Note, however, that it is still important in Africa, Middle East, and Mediterranean countries.
24136	7	37	20	37	24	Is there an uncertainty range on the emissions reduction estimates? Please clarify	Accepted. Uncertainties are specified
29187	7	37	25	38	5	In figure 7.9 (TS.19 Right panel), which shows comparative life-cycle greenhouse gas emissions for a range of different technologies. The figures for gas and coal CCS appear slighty different from those shown in figure 7.8. Figure 7.9 is referenced to Koorneef 2008, Singh 2011 and Ramirez 2012. What was the intention of using figures for CCS technology that make use of different literature?	Taken into account. The numbers have been updated to be consistent.
26619	7	38		38		Footnote 9 at the bottom of the page: the proper title of the IHA guidelines is: "GHG Measurement Guidelines for Freshwater Reservoirs" http://www.hydropower.org/iha/development/ghg/guidelines.html	Taken into account. Reference to non-journal document has been removed; not essential here.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33875	7	38	11	38	13	The statement, "The empirical basis for estimating the emissions associated with geothermal and ocean energy is much weaker." For geothermal, this is not the case; DOE has sponsored multiple life cycle analysis studies (refer to https://www1.eere.energy.gov/geothermal/environmental_analysis.html)	Taken into account. There are a number of individual studies out there, but the population of studies is still not representative given the large site variation. Please note that the link you provided did not work.
33780	7	38	12	38	14	but a range of 13 of 20-57 gCO2e/kWh for geothermal power has been identified. Please skip figure ocean energy (seems too low).	Taken into account. Please note that the figure of ocean energy has been replaced based on newer studies.
36849	7	38	12			"The empirical basis for estimating the emissions associated with geothermal and ocean energy is much weaker, but ranges of 20-57 gCO2e/kWh for geothermal power and 6-9 gCO2e/kWh for ocean energy have been identified (J. Sathaye et al., 2011a)." Can the authors provide other citations for the CO2 emissions from geothermal? See: http://www.worldenergy.org/publications/survey_of_energy_resources_2007/... Care must be used to determine how authors of reports with such numbers treat binary power and flashed geothermal. Binary plants in general have no CO2 emissions and only a small amount of hydrocarbon emissions. Flash plants can have significant (but less than 10% of gas turbine) emissions to nearly no CO2 emissions.	Taken into account. There are a number of individual studies out there, but the population of studies is still not representative given the large site variation. Please note that the link you provided did not work.
21208	7	38	14	39	7	Term "interquartile" needs to be replaced.	Editorial
32820	7	38	14	38	15	Quantify the emissions from enrichment.	Rejected. Not important enough to be mentioned here. This is discussed in the reference provided.
33781	7	38	15			… for nuclear power uranium enrichment …	Accepted.
32821	7	38	16	38	18	What are good conditions?	Editorial. Text has been reformulated.
33778	7	38	2			"Biogenic emissions from hydropower are not included." Figure 7.9 seems to indicate that biogenic emissions from hydropower are included, at least for hydropower sites outside tropical regions.	Taken into account. The figure has been replaced and biogenic emissions are now included.
19068	7	38	20	38	24	A hydro dam could be used to grow algae for bioenergy in controlled areas and be a source of animal protein	Rejected. No literature provided to support that this could be an important and beneficial technology.
26616	7	38	21	38	23	This sentence should indicate that dams, AS WELL AS UNRELATED ANTHROPOGENIC SOURCES CAN lead to accumulation of carbon carbon in the reservoir. This is per the IPCC's own previous publications.	Rejected. This issue has been treated more extensively in SRREN and there is not enough space here to address further potential causes of conditions described here.
26617	7	38	26	38	29	This sentence should also reference the role of unrelated anthropogenic sources (UAS) in contributing to anoxic conditions and methane production.	Rejected. This issue has been treated more extensively in SRREN and there is not enough space here to address further potential causes of conditions described here.
22553	7	38	27	38	27	after last comma in line 27 add <can> (can lead) since anoxia is not an automatic event	Accepted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24297	7	38	3	38	4	This conclusion is inconsistent with that shown in Fig 7.9, where life-cycle CO2 emission per kWh for NGCC-CCS is obviously higher than that for IGCC-CCS. Moreover, the range of life-cycle CO2 emission per kWh for NGCC-CCS shown in this sentence is underestimated. Odeh et al. summarized from other literature that the range of life-cycle CO2 emission is 200-245 gCO2/kWh for NGCC-CCS. Assuming a leakage of 1% of natural gas, Odeh's study indicated that life-cycle CO2 emission is 167 gCO2/kWh for IGCC-CCS and 200 gCO2/kWh for NGCC-CCS. It is suggested that the ranges in this sentence be changed to '167-300 gCO2e/kWh for coal and 120-245 gCO2e/kWh for gas power with CCS'. In addition, it is emphasized in Sections 7.2-7.4 that coal accounts for a significant share of current and future energy consumption and CO2 emission, thus it is appropriate to point out here the potential of emission reduction for the coal-based power stations, especially for IGCC-CCS. ——See"Naser A. Odeh and Timothy T. Cockerill (2008). Life cycle GHG assessment of fossil fuel power plants with carbon capture and storage. Energy policy 36, 367-380."	Taken into account. Please note that our original number referred to a more recent and detailed study of NGCC-CCS. Figures have been revised.
31536	7	38	3	38	4	This conclusion is inconsistent with that shown in Fig 7.9, where life-cycle CO2 emission per kWh for NGCC-CCS is obviously higher than that for IGCC-CCS. Moreover, the range of life-cycle CO2 emission per kWh for NGCC-CCS shown in this sentence is underestimated. Odeh et al. summarized from other literature that the range of life-cycle CO2 emission is 200-245 gCO2/kWh for NGCC-CCS. Assuming a leakage of 1% of natural gas, Odeh's study indicated that life-cycle CO2 emission is 167 gCO2/kWh for IGCC-CCS and 200 gCO2/kWh for NGCC-CCS. It is suggested that the ranges in this sentence be changed to '167-300 gCO2e/kWh for coal and 120-245 gCO2e/kWh for gas power with CCS'. In addition, it is emphasized in Sections 7.2-7.4 that coal accounts for a significant share of current and future energy consumption and CO2 emission, thus it is appropriate to point out here the potential of emission reduction for the coal-based power stations, especially for IGCC-CCS. ——See"Naser A. Odeh and Timothy T. Cockerill (2008). Life cycle GHG assessment of fossil fuel power plants with carbon capture and storage. Energy policy 36, 367-380."	Taken into account. Please note that our original number referred to a more recent and detailed study of NGCC-CCS. Figures have been revised.
20490	7	38	3			CO2 capture plants (insert: are expected) to reduce	Editorial
20491	7	38	3		7	see comment No 5	Rejected. Reference not found
20458	7	38	3	37	5	The numbers you provide in the text are inconsistent with the numbers presented in Figure 7.9. A determination of which number is appropriate should be made and the two points should be made consistent. It's also not clear why you state leakage rates are assumed much higher or what this references. I'm not sure what study conclusively estimates that leakage rates for natural gas are much higher, but rather there remains uncertainty from the various studies.	Rejected. Please note that the text states that the cited value, as identified in the literature, is no longer valid because fugitive emissions are higher.
23299	7	38	3			Change "CO2 capture" to "CCS" and delete "with CCS" from line below	Accepted
25171	7	38	3	38	19	The coverage in this section conflicts with the analysis presented on page 41 lines 118-24. The prioritization of one valuation over the other could be criticized as failing to present disinterested and relevant information.	Rejected. We did not understand what this comment refers to.
21844	7	38	39			Give some brief detail on the ideas for mitigating existing methane emissions.	Rejected. This issue is addressed in 7.5.1
26618	7	38	39	38	42	Hydropower reservoirs, and any associated emissions, are highly site-specific - depending on local conditions such as temperature, precipitation, runoff, and local unrelated anthropogenic sources. Attempting to extrapolate a world-wide average based on a selected number of site-specific reservoirs from a sample that is unrepresentative of global conditions, is not scientifically sound. This sentence should be adjusted to remove the inference that global emissions are 40gCO2e/kWh.	Rejected. The comment disputes the correctness of assessments provided in the peer-reviewed literature. If the commenter has evidence that the cited results are incorrect, please direct these in an appropriately written piece to the journal.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32819	7	38	4	38	5	Quantify the actual leakage rate or the assumed one; provide reference.	Rejected. The comment must be misplaced; it makes no sense when refering to the opening sentence of this section
22554	7	38	42	38	42	a bit unclear what is meant by "fossil GHGs"	Accepted. Text changed to "fossil fuel combustion and cement production"
32822	7	38	45	39	2	Reference needed.	Taken into account. The section has been shortened and the comment no longer applies.
33779	7	38	5			"but actual leakage rates are now assumed to be higher." Even if methane leakage rates are higher, GHG emissions from natural gas CCS in Figure 7.9 (310-330 g CO2-eq/kWh) appear to be too high. See for instance: ICF (2012): Life Cycle Greenhouse Gas Emissions of Natural Gas. ICF Consulting Canada, December 2012.	Rejected. The figure refers to what several publications see as the likely range of emissions connected to gas. This is higher than 1%, and hence the statement is justified.
21144	7	38	5	38	5	Check referencing style, Andrea is a forename and Ramirez is the lastname	Editorial
23300	7	38	5			Assumed by whom?No reference.	Taken into account. A reference to section 7.5.1 has been added.
36848	7	38	5	38	5	"actual leakage rates are now assumed to be higher" seems overly confident given non-existence of useful field data suggesting this -- suggest "some have claimed that actual leakage rates are higher". Also suggest providing a citation for whatever statement the authors end up with.	Taken into account. The statement was not changed but the reader is now referred to section 7.5.1 where this issue is discussed providing more extensive references.
23745	7	38	6	38	10	Here there is space to comment on biomass power generation. See for example Pacca, S. and J. R. Moreira, 2011. A Biorefinery for Mobility? Environ Sci Technol. 2011 Nov 15;45(22):9498-505.	Rejected. Mobility issues are covered in Ch.8
23301	7	38	7		15	Largely repetition of Fig 7.9 so delete.	Rejected. Please note that the text makes the connection between new assessments presented in the figure and SRREN/literature produced for SRREN. For most technologies, these support each other, but there are some differences.
32824	7	39		39		What are the percentage changes shown in this Figure?	Taken into account - the comment is obsolete as the % values have been deleted.
20492	7	39				There should be two Figures. One for those technologies already in operation/construction and one for those where only design studies exist. I assume, that the Figure will be updated according to the latest figures. Current median for new nuclear is 94$/MWh according to Bloomberg. What $ year is used here? is it the same for 2009 and 2012?	Accepted - figure layout changed.Cost data were updated by using a considerably increased number of sources.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25718	7	39				The estimated cost for CCS in this figure should be revised to show the range of possible CCS cost because CCS cost depends on a number of conditions such as concentration of CO2 in the exhaust gases, capture technology, access to storage site, storage potential, and CO2 monitoring, as described in (Finkenrath, 2011, page7), (Rubin, 2007, page4447, Table3), and (Lohwasser, 2012, Abstract). These literatures are listed in the No12 line of this table. In addition, the estimated cost for onshore wind in this figure should be revised to extend the range to the estimated cost of 180US$/MWh, that is assessed by verification committee for generation cost of Japanese government in December 2011.	Accepted - figure layout changed.Cost data were updated by using a considerably increased number of sources.
27068	7	39				It makes no sense to leave out the cost ranges of producing electrcity from gas or coal. It is not a good idea to use different sources in the same figure. The Global CCS Institute is probably not the best independent source for the cost of CCS (Scottish and Southern Energy (SSE) in the UK reports far higher figures from their acutal projects than thos stated here. If the authors insist on using IEA figures for nuclear cost (which are outragiously out of touch with the situation in the market place), more recent data than 2010 is available from the IEA. In an interview with Daily Telegraph 12/8 2012, EDF (one of the largest nuclear operators in the world) CEO de Rivaz is talking about cost around £140/MWh (US$ 225/MWh) to build Hinkley Point in the UK - more than double the highest point of the nuclear cost range in the graph. No power company will confirm that you can build new nuclear at anything close to the range indicated in the graph. Various reports for Hinkley put the cost at £7 billion per reactor (1,600 MW each) or £4,375/MW (US$ 7,100/MW). See http://www.telegraph.co.uk/finance/newsbysector/energy/9470555/EDF-chief-Vincent-de-Rivazs-nuclear-vision-aims-to-inspire-a-generation.html	Taken into account, but rejected in part - figure layout changed.Cost data were updated by using a considerably increased number of sources. The numbers given in an interview are not a valid source for an IPCC report.
26835	7	39				Comparing today's costs for renewables to estimated costs for nuclear in 2015 is misleading. If current cost data for Nuclear are not available, then a separate table that compares projected costs for power generation technologies in 2015 should also be included. PV, CSP, and wind (outside of China and India) will be cheaper by then.	Rejected - the table intends to show the current data of commercial technologies.Those of pre-commercial ones, for which current costs are not available are shown separately.
26836	7	39				The low-end of the Nuclear cost range for a 10% rate of return is very low, I don't believe this is feasible for 2015 in most markets	Rejected - the low end by definition is the minimum value (achieved in Asia), not the one for "most markets".
26837	7	39				the lower end for PV seems quite optimistic for 2012. Does this include projects in US with the production tax credit? I would consider this a subsidy as it differs from standard company taxation	Noted - subsidies are not taken into account.
26838	7	39				STEG LFR range seems too high, it should have similar low-end to parabolic trough with no storage	Taken into account - comment is obsolete as LFR collectors are not shown separately anymore.
26839	7	39				Please consider the data in IRENA 2013, 2013 (IRENA (2013), Renewable Power Generation Costs in 2012: An Overview, IRENA, Abu Dhabi).. We would be happy to provide more detail as needed	Taken into account - IRENA cost data are now taken into consideration.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26382	7	39	10	39	19	SPECIFIC COMMENT. I suggest to include fuel cells LCOE data in Figure 7.10 (that "shows a current assessment of the cost of various low carbon energy supply technologies and their change compared to those values that were considered in the IPCC SRREN (2011a)"). In particular I suggest to include: the Fuel Cells ENE-Farm LCOE data as provided by the Japan National Policy Unit (NPU) Energy and Environment Council's Cost Review Committee in "Cost Review Committee Report"; the Fuel Cells plant LCOE data (referred to the US context) as provided by OECD-IEA-NEA in "Projected Costs of Generating Electricity" (2010 Edition); the H2FC Powertrain LCOE 2017 data target as indicated in M.V. Romeri analyses. So, it is necessary to integrate consequently the text: "Figure 7.10 Levelised cost of energy as observed for the fourth quarter of 2012 (and for the second quarter of 2009) Source: For renewables and fossil fuels: Bloomberg New Energy Finance (2012); for nuclear: IEA (2010c); for CCS: Global CCS Institute (2011); for Fuel Cells: NPU (2011) and IEA (2010); for H2FC Powertrain: M.V. Romeri (2012)". REFERENCES. ENE-Farm, see: M. Akai, "Stationary Fuel Cell Programme in Japan", IEA-EGDR Workshop, Paris 2010, < http://www.iea.org/media/workshops/2010/transforminginnovation/akai.pdf >; S. Eguchi, "ENE-FARM Fuel Cell Systems for Residential Use", 2009, <http://www.igu.org/knowledge/publications/mag/oct-09/igu_october_2009_7_pages_186-217.pdf >; T. Ito, "NEDO's activities on Fuel Cells and Hydrogen in Japan", Nov. 2011, <http://webcast.ec.europa.eu/eutv/portal/pdfgenerator?id=13440 >. ENE-Farm LCOE, see: Japan National Policy Unit (NPU) Energy and Environment Council's Cost Review Committee, "Cost Review Committee Report" (コスト等検証委員会報告書 平成23年12月19日), Tokyo 2011 (p. 62), <http://web.archive.org/web/20130221042347/http://npu.go.jp/policy/ policy09/pdf/20111221/hokoku.pdf > or, "Electricity Generation Cost by Source" (主な電源の発電コスト) <http://web.archive.org/web/20130221042625/http://npu.go.jp/policy/policy09/pdf/20111221/hokoku_kosutohikaku.pdf >. Fuel Cells plant LCOE, see: OECD-IEA-NEA "Projected Costs of Generating Electricity", 2010 Edition, <http://www.oecdbookshop.org/oecd/display.asp?lang=EN&sf1=identifiers&st1=978-92-64-08430-8 > or <http://www.debateco.fr/sites/default/files/2010%20IEA%2BOECD%20on%20Costs%20 Electricity%20.pdf>. H2FC Powertrain LCOE, see M.V. Romeri analyses: "Considering Hydrogen Fuel Cells Powertrain as Power Generation Plant" presented at EVS25, 2010, Shenzhen, Guangdong, China, published in World Electric Vehicle Journal Volume 4 (2011), <http://www.evs24.org/wevajournal/php/download.php?f=vol4/WEVA4-4131.pdf >; "Hydrogen Fuel Cell Powertrain Levelized Cost of Electricity" presented at the 30th USAEE/IAEE North American Conference, 2011, Washington DC USA, published by USAEE & IAEE Research Paper Series, <http://ssrn.com/abstract=2006758>; "The Hydrogen Fuel Cell Vehicles Powertrain Roles in the Copenhagen Accord and Cancun Agreement Perspective" presented at 2011 Fuel Cell Seminar & Exposition, Orlando FL USA, and published by ECS The Electrochemical Society, ECS Transaction, Volume 42 < http://ecst.ecsdl.org/content/42/1/59.abstract >; "Consideration about the Hydrogen Fuel Cell Powertrain LCOE" presented at the 3rd IAEE Asian Conference, Kyoto, Japan, 2012, <http://eneken.ieej.or.jp/3rd_IAEE_Asia/pdf/paper/025p.pdf >; "Consideration about Hydrogen Fuel Cell Powertrain Levelized Cost of Electricity" presented at CARS 21 Public Hearing 2012, European Commission, DG Enterprise and Industry, Automotive Industry Unit. Brussels Belgium, <http://circa.europa.eu/Public/irc/enterprise/automotive/library?l=/cars_working_groups/cars_hearing_2012/romeri	Rejected - space constraints do not allow to show the costs for every specific technology.
36852	7	39	11	39	11	"energy supply technologies"? This appears to be electricity generation technologies, not all energy supply technologies. This is a valid and interesting comparison but it needs to be labeled clearly.	Accepted - text revised.
24648	7	39	12	39	15	Further suggested citation: Australian Bureau of Resources and Energy Economics (BREE) (2012). Australian Energy Technology Assessment. BREE, Canberra, July (www.bree.gov.au). This study provides up to date estimates of LCOE for 40 electricity generation technologies now and out to 2050.	Noted - the figure now is based on a much larger set of input data.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26909	7	39	15			The point cost estimates of CCS presented in this graph should be revised, as they are based on a single study from an self-proclaimed advocacy organization (from the Global CCS Institute's "About" page: "The Institute advocates for CCS as one of the options required to reduce greenhouse gas emissions,..."). Using a reference from such an organization is not acceptable within the IPCC, even if it were one of many citations for a given point. Yet, egregiously, this study is the only study upon which the presented CCS cost estimates are based, which casts significant doubt on the validity of the CCS cost estimate. As such, a different reference for CCS cost estimates should be used; CCS pilot projects exist from which cost ranges could be obtained, and there are also many peer-reviewed studies estimating the cost of CCS (see reference, e.g., at end of this comment). The fact that no commercial scale CCS project exists makes the low point estimate (that is competitive even with onshore wind) for CCS highly suspect. A better study would be: "Cost and Performance of PC and IGCC Plants for a Range of Carbon Dioxide Capture." U.S. National Energy Technology Laboratory. 27 May 2011.	Taken into account - the data provided by the CCS institute are replaced by other sources.
26910	7	39	15			This graph should include the LCOE of conventional generation technologies, e.g. coal and gas without CCS. The costs of these technologies are crucial to understand the challenge facing low-carbon technology; without presenting these costs, one cannot contextualize the costs of low-carbon technology and understand that the reason they are not deployed at large scale is because they remain more expensive than conventional generation.	Accepted - conventional technologies now are shown as well.
29661	7	39	16			The point cost estimates of CCS presented in this graph should be revised, as they are based on a single study from the Global CCS Institute. Citing this advocacy organization is not acceptable for the IPCC and would cast significant doubt on the information presented in this figure and beyond. If a peer-reviewed estimate cannot be found, CCS should not be included in this figure, though an explanation for its absence may be included in the legend. Further, the complete lack of commercial scale CCS projects makes this low point estimate for CCS highly suspect. While costs will surely come down in the future, they have not been demonstrated at this level. A potentially useful study to consider for citation would be: "Cost and Performance of PC and IGCC Plants for a Range of Carbon Dioxide Capture." U.S. National Energy Technology Laboratory. 27 May 2011.	Taken into account - the data provided by the CCS institute are replaced by other sources.
21409	7	39	16	39	19	To clarify what componets (i.e. capture, transport and storage) are included in the CCS costs shown in the Figure 7.10. Add amounts of cost of each component (i.e. capture, transport and storage).	Accepted - assumptions made about storage and transport costs are added.
21847	7	39	17	39	19	Fig 7.10 is a great example of a clear update on knowledge since AR4 in terms of production costs for energy technologies - although clarify if this is energy or electricity. (Appropriateness of using industry advocacy body data not withstanding). Some data points are difficult to comprehend: e.g., how offshore wind can range so high when GWs of offshore capacity have been added in the last 5 years, and how CCS (e.g., oxyfuel) can be so inexpensive when (to my knowledge) none have been built, and ex ante engineering predictions are invariably underestimates. It woud be useful to distinguish which data are based on market performance and which based on desk-studies / models / assumptions.	Accepted - figure layout changed.Cost data were updated by using a considerably increased number of sources.
20725	7	39	3	39	6	Again, this review fails to pick up on the wide dispersion of results due to location, etc.	Noted. The text has been revised. See comment 20742

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21845	7	39	3	39	6	This section on potential reductions from mitigation measures is almost entirely focused on electricity, and is a good example of the imbalance throughout the chapter. What about potentials in heat, liquid fuels, other energy carriers (e.g., H2), and so on?	Rejected. Electricity production accounts for 80% or so of emissions in the energy supply sector, which is the rationale for focusing on these. There is unfortunately not enough space for a discussion of heat and refining.
23752	7	39	3	39	6	Add discussion about bioelectricity from waste or crops by-producys. Make this compatible with Figure 7-10.	Accepted
33782	7	39	4			… in many cases of …	Editorial
19644	7	39	4	39	4	Spelling: cases (not 'cased')	Editorial
36850	7	39	4	39	4	cased --> cases	Editorial
32823	7	39	5	39	6	This point was made earlier and must be defended.	Taken into account.
21846	7	39	5	39	6	The potential for learning improvements is not an inevitability, and it is important learning potentials are dealt with separately, coherently, consistently across the full portfolio of mitigation options, and also critically.	Taken into account. This is now supported by specific references. There is no space for a section on learning improvements.
21853	7	39	7	42	27	This section on mitigation costs needs to conclude with a clearer comparative analysis for the full portfolio of mitigation options/measures linked to the mitigation potentials AND importantly needs to extend beyond electricity options, both upstream and also energy carriers (conversion and distribution) including heat and liquid fuels.	Rejected - the sector chapter are constrained to a discussion of the pure technology costs. Chapter 6 provides a discussion of the entire portfolio. The other sector chapter give data on heat and fuel technologies.
36851	7	39	9	39	9	The AnnexII spells "levelised" as "levelized" One spelling version or the other should be used throughout the report in all chapters.	Accepted - one version is used (levelized)
26834	7	39	15	39	15	Include on line 15 a reference to IRENA, 2013 (IRENA (2013), Renewable Power Generation Costs in 2012: An Overview, IRENA, Abu Dhabi).	Taken into account - IRENA cost data are now taken into consideration.
24647	7	39	7	39	15	This paragraph and table well written - please keep if shortening the chapter	Noted.
23924	7	39	9	39	10	The LCOE is not a suitable metric for intermittent energy generation comparison. P. L. Joskow, 2011. Also, the LCOE model by NREL fails to include the full costs associated with renewables. See also Falko Ueckerdt, Lion Hirth#, Gunnar Luderer*, Ottmar Edenhofer on Costs of Variable Renewables. You do qualify its use on page 40, but why use in the presentations when it is not represenative of the true cost of renewables?	Taken into account - LCOE have merits and shortcomings. As a comprehensive comparison of the entire costs of all mitigation technologies is currently not possible, it makes sense to show those costs which can be determined. Nevertheless, the respective shortcomings must be emphasized. This is done in 7.8.2 and even more in Annex 2 where the paper of Joskow is cited. The paper of Ueckerdt et al. has been added.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20990	7	39		40		In this section, mitigation costs are assessed by comparing average costs (LCOE). This is problematic, given that the value of electricity depends on the point in time and space it is produced. Of course electricity from a gas turbine is more expensive than electricity from a nuclear plant; that does not imply anything for cost-benefit analysis or the economic efficiency of one or the other option. This section should at least refere to this problem and point to Joskow (2011), Borenstein (2012), Mills & Wiser (2012), Hirth (2013). Joskow, Paul (2011): "Comparing the Costs of intermittent and dispatchable electricity generation technologies", American Economic Review 100(3), 238–241. Borenstein, Severin (2012): "The Private and Public Economics of Renewable Electricity Generation", Journal of Economic Perspectives 26(1), 67–92. Mills, Andrew & Ryan Wiser (2012): "Changes in the Economic Value of Variable Generation at High Penetration Levels: A Pilot case Study of California", Lawrence Berkeley National Laboratory Paper LBNL-5445E. Hirth, Lion (2013): "The Market Value of Variable Renewables", Energy Economics (http://dx.doi.org/10.1016/j.eneco.2013.02.004).	Taken into account - LCOE have merits and shortcomings. As a comprehensive comparison of the entire costs of all mitigation technologies is currently not possible, it makes sense to show those costs which can be determined. Nevertheless, the respective shortcomings must be emphasized. This is done in 7.8.2 and even more in Annex 2 where some of the cited papers are added to the reference list.
26790	7	4		6		The executive summary does not follows the chapter CCS is presented before renewables and should be after nuclear	Accepted - sequence of discussion now follows the sections in 7.5.
33863	7	4	0	6	0	The Executive Summary should focus on the identified solutions in which Energy Systems can mitigate climate change for generations to come.	Taken into account - the ES mainly discusses low carbon technologies. Option that might be useful in the short and medium term, however, are discussed as well.
33865	7	4	0	6	0	The Executive Summary should be shortened to one page (e.g., refrain from editorial and historical background information)	Rejected - the ES has to summarize the main points in the body text. It has been rewritten to serve that purpose in a concise way within the given number of admissible pages.
20454	7	4	1	4	6	Can you clarify this paragraph to make it clear whether or not the energy sector includes power generation? Alsc, if this does include power generation it would be worthwhile to know what componet of energy sector emissions from power generation versus all other emissions.	Taken into account - Energy conversion includes power generation. Graphical illustration of the chapter boundaries is presented in Fig. 7.1.
34150	7	4	11		14	The notion of Annex-1 and non-Annex 1 countries is outdated. The authors should check whethere the distinction makes any sense still.	Taken into account - Annex 1 - non Annex 1 differentiation is not used in the ES.
21112	7	4	11	4	14	Add a footnote to explain what are the Annex I and non-Annex I countries	Taken into account - It will be given in the glossary.
36698	7	4	11	4	14	Suggest that the autors revise the confidence level upwards: Medium agreement/evidence (l. 13-14) is inconsistent with an apparently unequivocal statement of fact (l. 11-13). If the problem is data uncertainty in 2008, consider citing a later year, where the situation is more clear cut.	Taken into account - the comment is obsolete as the underlying text has been deleted.
26897	7	4	12	4	14	As presented, the statement that Annex I countries as a group have kept emissions below 1990 levels since 2008 does not include imported emissions. Including imported emissions would provide a more accurate depiction of the responsibility for GHGs among Annex I countries, and so this statement shoudl be revised to include imported GHG emissions. (This statistic is reported later in the chapter.)	Taken into account - the comment is obsolete as the underlying text has been deleted.
21114	7	4	13	4	13	A conclusion on the practical feasibility of geologic storage is missing.	Taken into account - the comment is obsolete as the underlying text has been deleted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21115	7	4	14	4	21	Mention as well improvements in Offshore transmission technology allowing to transmit over longer distances	Rejected - too detailed for inclusion in ES, which is VERY space constrained
34151	7	4	15		19	Please use GtCO2 instead of GtC. Also make explicit what the time horizon of aggregtaion is. The issue of hydro-carbon reserves depends on the non-conventional gas reserve that forms the largest share and that has been increased significantly by geological surveys during the last few years. Hence, the conclusion depends on the quest of non-conventional gas reserves.	Taken into account - comment is obsolete as the underlying text has been deleted.
26898	7	4	15	4	19	This paragraph starts with using "reserves" but then later (line 17) uses the word "resources". It is not clear whether that line should actually refer to "reserves", i.e. "limits to fossil fuel reserves…", or resources.	Taken into account - the comment is obsolete as the underlying text has been deleted.
24628	7	4	15	4	19	This discussion would benefit from more balance in terms of the feasibility of reducing emissions from fuel switching within fossil fuels. Recent IEA analysis that suggests we simply cannot afford to burn more than a third of our fossil fuel reserves without exceeding the dangerous concentration of GHGs in the atmosphere. This has serious implications for the economic system, through impacts on the asset values of fossil fuel businesses, but also potential benefits such as a reduction in energy import costs for many developing countries and policies on future exploration for fossil fuels, and expansion of production capacity. Citation: International Energy Agency (IEA) (2012). World Energy Outlook 2012- Executive Summary. OECD/IEA 2012 (http://www.iea.org/publications/freepublications/publication/English.pdf)	Taken into account - the comment is obsolete as the underlying text has been deleted.
21097	7	4	15	4	19	This paragraph should mention explicitely the gobal carbon budget allowed (by 2050 for example) to remain consistent with Cancun agreement, as is done by IEA in the WEO 2012 when she states than no more than a third of fossil fuel reserves can be used in the 450 scenario.	Taken into account - the comment is obsolete as the underlying text has been deleted.
36699	7	4	16	4	16	Intended meaning of "remaining reserves" is unclear. Please clarify, by specifying (i) "resources", (ii) "proven reserves", or (iii) simply "reserves" (proven + unproven), i.e., Technically Recoverable Resources (TRR). Terminological accuracy is key, as these concepts are related but non-equivalent - (iii) being a subset of (ii), and (ii) a subset of (i). See also http://www.eia.gov/todayinenergy/detail.cfm?id=7190	Taken into account - the comment is obsolete as the underlying text has been deleted.
23248	7	4	17			After "carbon" add: …… with known resources much higher.	Taken into account - comment is obsolete as the underlying text has been deleted.
36697	7	4	2	4	4	Is "The energy sector" defined this way in the entire report? Did the authors intend to say "in this chapter"	Taken into account - "Energy sector" now is replaced by "Energy supply sector" and this term is used consistently throughout the report.
34152	7	4	20		24	The list misses the very important issue of bio-energy.	Rejected - bio-energy is part of renewable energies.
30437	7	4	20			Might add reduction in continuous associated gas flaring and venting in oil and gas fields as a significant reduction potential (reference World Bank GGFR program - Global Gas Flare Reduction). Also, coal-bed methane emissions reductions could be mentioned. The other high impact area is end -user demand reduction which will have a multiplier effect upstream (reduced demand - reduce supply - reduction in transport and manufacturing, etc)	Taken into account. Given that there is such a high uncertainty about the size of fugitive methane emissions, it is hard to judge that this is a priority area. Nevertheless, mitigation option related to the fossil fuel chain now are mentioned explicitly.
32991	7	4	20	4	24	The options presented here are not all discussed in the remaining ES text - e.g. fugitive emissions in extraction. A balanced coverage could be useful.	Accepted. Text revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32992	7	4	20	4	24	For reasons of consistency, it would be useful to list the mitigation options here exactly as they appear in Section 7.5.	Accepted - text revised.
27758	7	4	20	4	24	What does "primary" mean in this context? Why is fuel shift from coal to gas not a primary mitigation option?	Accepted - text revised in order to avoid any misunderstanding.
21116	7	4	22	4	24	Also mention the challenges on balancing electricity systems with large shares of intermittent generation which results in increased need for thermal backup	Accepted - text revised
25588	7	4	25	4	27	There are many opportunities for significant reductions in GHG emissions. Why do you focus on replaces from coal power to NGCC in this sentence although there are many opportunities to reduce GHG emissions in energy sector? For example, there are also large emission reduction potentials by replacing from conventional coal powe in developing counties to the best available high efficiency coal power. On the other hand, there are larger emission reduction potentials of replacing from coal power to nuclear power or renewables. Specific measures should not be focused here.	Noted - replacing coal by gas is the most important option in the field of fossil fuel switching. RE, nuclear and CCS are discussed in detail in other parts of the ES.
34153	7	4	25		27	The paragraph misses to note the issue of fugitive emissions and own energy cnsumption (especially liquefaction for LNG), which is disputed in the literature.	Taken into account. Given that there is such a high uncertainty about the size of fugitive methane emissions, it is hard to judge that this is a priority area. Nevertheless, mitigation option related to the fossil fuel chain now are mentioned explicitly.
34156	7	4	25		42	The coal vs. gas issue has to be viewed with respect to trade and development. Some of the developing countries are rich in coal, but scarce in gas (e.g. India, and China partially). Hence, the gas switch requires them to built up an infrastructure and import gas, leaving the coal underground. Though, this is technically and - probably - ecoomiically not a prohibitive issue, but politically it is sensitive. For national policy makers in the context of international issues it is important. If climate change mitigation requires more gas international gas trade in the near term, then we may also need accelerated integration of international gas markets. The paper by Zhang et al (2013) considers these issues for China (see figures 4-5 in the attached paper). The graphs show that under various conditions of cliamte change mitigation will lead to higher natural gas use in the electricity sector. Increasing the gas import costs for China will decrease the use of gas in the power sector. These arguments are important for the IPCC AR5 because it shows that international climate policies might also lead to additional (or re-adjusted) priorities in other fields of international polcies. See the paper Zhang_APEN-S-13-00244.pdf.	Rejected - The statement does not say that this strategy should be preferred over other strategies, e.g. coal with CCS, nuclear or renewable. The political aspects cannot be discussed in the ES due to severe space constraints.
26901	7	4	25	4	42	I appreciate the inclusion of the uncertainty about fuel chain issues on the life cycle GHG emissions of natural gas, and this should be kept in the Executive Summary. It is worth considering, though, moving the discussion of the inability of NGCCs to meet long-term stabilization targets (line 38) higher in the natural gas discussion, as this is a crucial point in understanding the pros and cons of natural gas expansion.	Accepted - a statement that cheap gas is not the final solution now is part of the first statement related to natural gas as a mitigation options.
24289	7	4	25	4	27	“Significant reductions in GHG emissions can be obtained by replacing existing coal fired heat and/or power plants by highly efficient natural gas combined cycle (NGCC) power plants or combined heat and power (CHP) plants.” This is technically feaisible, but it requires laarge-scale financial investment for construction or upgrade. NGCC may also be very expensive for countries with limited resources of natural gas. It is suggested to add "subject to the avaliablity of financial resouce and natural endowment" at the end of this sentence.	Taken into account. The statement does not say that this strategy should be preferred over other strategies, e.g. coal with CCS, nuclear or renewable. The availability of gas now is mentioned.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
31528	7	4	25	4	27	“Significant reductions in GHG emissions can be obtained by replacing existing coal fired heat and/or power plants by highly efficient natural gas combined cycle (NGCC) power plants or combined heat and power (CHP) plants.” This is technically feaisible, but it requires laarge-scale financial investment for construction or upgrade. NGCC may also be very expensive for countries with limited resources of natural gas. It is suggested to add "subject to the avaliablity of financial resouce and natural endowment" at the end of this sentence.	Taken into account. The statement does not say that this strategy should be preferred over other strategies, e.g. coal with CCS, nuclear or renewable. The availability of gas now is mentioned.
20469	7	4	25		26	"existing caol fired heat and/or power plants" should be replace by "low efficiency … plants"	Taken into account. Existing has been deleted.
20470	7	4	25		46	The five paragraphs have to be streamlined with arguments presented later in the report and it should be spelled out that NGCC and CCS for coal and gas are no longterm solutions. See page 37 line 21 where it is stated that average emissions have to be reduced to below 100g CO2 per kWh and in Fig. 7.9 and page 38 line 3 it is shown,m that neither coal nor gas CCS reaches this goal.	Taken into account. Text has been revised. Note that fossil fuel CCS might only be a transitional technology, but BECCS might allow for emissions below 100g. What is discussed are the issues related with CCS, independent of the input fuel.
25701	7	4	25	4	31	This part should be revised to explain that it is important to use coal power efficiently from a viewpoint of energy security and economic efficiency. IGCC (Integrated Gasification Combined Cycle) technology is developing and has potential to reduce CO2 emission in the future, as described in (IEA, 2011, page7, page42 Fig14) and (Janos, 2009, page5, page7 Figure1 and Table 1). These literatures are listed in the No10 line of this table.	Taken into account - energy efficiency improvements in energy conversion now is mentioned explicitly.
33864	7	4	25	4	27	This statement is not applicable to the long-term. It is true that natural gas has the ability to reduce GHG significantly during the power generation process, but the authors must consider lifecycle GHG effect, whereby renewable energy sources are more effective than natural gas. It is equally important to place emphasis on reducing energy conversion and transmission losses.	Taken into account. The text has been revised to so that the statement about reductions is followed immediately with a statement that these reductions are not sufficient to meet the Cancun target.
29781	7	4	25		27	This paragraph is a very generalising statement without any consideration to the limitation of NGCC and CHP. Coal fired power plants will have a significant contribution to the overall energy mix. By converting all coal fired power plant is very uneconomical - as this is not be the best options for all countries who has limited resources of NG. Furthermore, this statement did not even consider the differences between baseload or peak duty - which make coal cost competitive on baseload duty (as example).	Taken into account. The statement does not say that this strategy should be preferred over other strategies, e.g. coal with CCS, nuclear or renewable.
36700	7	4	25	4	27	Suggest that the autors revise the confidence level upwards: Medium confidence/agreement does not apear to be consistent with the literature. Only a small number of outlier papers - all strongly contested - oppose this contention.	Rejected. As long as there are some serious doubts remaining, in the absence of measurements and a common interpretation of those, neither robust evidence nor strong agreement are justified.
36701	7	4	25	4	32	Suggest making reference to fugitive emissions from natural gas operations here, something that is discussed later in the chapter.	Accepted - text revised by adding a statement on fugitive emissions.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
35383	7	4	27			Add 'excluding MSW incinerators'. Even when incinerators plants are CHP, the GHG emission reductions that can be achieved by incinerating the MSW are much lower than what can be achieved by reducing, reuse and recycling the same waste. It should not be emphasized as a mitigation strategy when this may pose an incentive to increase incineration of waste instead of promote material efficiency, which is de facto a much greater mitigation strategy. References: US EPA, Solid Waste Management and Greenhouse Gases: A Lifecycle Assessment of Emissions and Sink. 3rd Edition, 2006; Morris, J., “Recycling versus incineration: an energy conservation analysis”, Journal of Hazardous Materials 47 (1996), 277-293; D. Hogg, A Changing Climate for Energy from Waste? Eunomia Research & Consulting for Friends of the Earth, 2006; Tellus Institute, Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan, Review submitted to the Massachusetts Department of Environmental Protection, 2008.	Rejected. This issue is not important enough to warrant attention here. Note that MSW incinerators are not presented as a mitigation option at page 4, line 27 of the ES.
35436	7	4	27			Add 'excluding MSW incinerators'. Even when incinerators plants are CHP, the GHG emission reductions that can be achieved by incinerating the MSW are much lower than what can be achieved by reducing, reuse and recycing the same waste. It should not be emphasized as a mitigation strategy when this may pose an incentive to increase incineration of waste instead of promote material efficiency, which is de facto a much greater mitigation strategy. References: US EPA, Solid Waste Management and Greenhouse Gases: A Lifecycle Assessment of Emissions and Sink. 3rd Edition, 2006; Morris, J., “Recycling versus incineration: an energy conservation analysis”, Journal of Hazardous Materials 47 (1996), 277-293; D. Hogg, A Changing Climate for Energy from Waste? Eunomia Research & Consulting for Friends of the Earth, 2006; Tellus Institute, Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan, Review submitted to the Massachusetts Department of Environmental Protection, 2008.	Rejected. This issue is not important enough to warrant attention here. Note that MSW incinerators are not presented as a mitigation option at page 4, line 27 of the ES.
26944	7	4	27			Add 'excluding MSW incinerators'. Even when incinerators plants are CHP, the GHG emission reductions that can be achieved by incinerating the MSW are much lower than what can be achieved by reducing, reuse and recycing the same waste. It should not be emphasized as a mitigation strategy when this may pose an incentive to increase incineration of waste instead of promote material efficiency, which is de facto a much greater mitigation strategy. References: US EPA, Solid Waste Management and Greenhouse Gases: A Lifecycle Assessment of Emissions and Sink. 3rd Edition, 2006; Morris, J., “Recycling versus incineration: an energy conservation analysis”, Journal of Hazardous Materials 47 (1996), 277-293; D. Hogg, A Changing Climate for Energy from Waste? Eunomia Research & Consulting for Friends of the Earth, 2006; Tellus Institute, Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan, Review submitted to the Massachusetts Department of Environmental Protection, 2008.	Rejected. This issue is not important enough to warrant attention here. Note that MSW incinerators are not presented as a mitigation option at page 4, line 27 of the ES.
34155	7	4	28		32	It is not really clear what the value added to the previous paragraph. The authors are urgently requested to put the two together and qualify the issue of figutive emissions and own-energy consumtpion.	Accepted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33866	7	4	28	4	32	Given the market characteristics of natural gas, its use in some countries might not be an option.	Taken into account. The statement does not say that this strategy should be preferred over other strategies, e.g. coal with CCS, nuclear or renewable. The sentence does not make any statements about the associated costs. However, a qualifier ("Where natural gas is available") is added to the statement, in order to take the possibility into account that gas is not available in every country.
36702	7	4	28	4	32	Please explain the nature of the disagreement? If it is whether some gas is low GHG then that is irrelevant -- the statement is already qualified. Suggest either deleting "low GHG" or increasing the level of confidence.	Taken into account. Please note this statement has been removed.
26253	7	4	3	4	3	7.10 Barriers and opportunities (technological, physical, financial, institutional, cultural, legal) could be shortened to 7.10 Barriers and opportunities	Taken into account - brackets will be removed.
20845	7	4	30	4	31	We can reduce large amounts of GHG emission by popularizing the best available technology of coal power. Effectiveness of it should be noticed.	Taken into account. "Efficiency of conversion " now is part of the mitigation option list. The effectiveness of this option, however is constrained as it would imply a lock in into a system which doesn't allow to achieve low stabilization targets, for instance those of the Cancun Agreement.
34154	7	4	33		37	The shale gas assessments are highly disputed. There are highly optimistic assessments (eg GEA), but there are also more pessimistic assessments (e.g. US-EIA). However, the assessments of conventional gas also increased in the past (especially for Russia and the Middle East). The IPCC should make a decent assessment with a fair and balanced view of the state and recent changes of fossil fuels in general and gas in particular based on scientific evidence.	Taken into account - the ES and the underlying text has been improved in order to better support the statement.
36703	7	4	36	4	36	Do the athors mean "...fuel switching to natural gas", not simply fuel switching?	Taken into account - comment is obsolete as the statement has been removed.
21098	7	4	38	4	39	More precision should be used here : what is « long term » ? Is the use of NGCCs in the 2030s, 2040s or 2050s still compatible with the reach of stabilization targets ?	Taken into account. Language changed.
23249	7	4	38			Suggest: …….emissions from NGCC plants used for satisfying base-load power demand would be too high….	Taken into account - text has been revised to avoid any misunderstanding.
20248	7	4	38	4	42	KEEP this para as it is important summary for policy makers regarding NGCC. Move this para to SPM.	Taken into account.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20442	7	4	4	4	6	Declaring the contribution of the energy sector to global GHG emissions, also sulphur and other particle emission should be mentioned, as be done on page 6, line 5 to 6 in another connection. Due to negative radiation forcing of these particles, the relative contribution of the energy sector to global warming will be smaller than its relative contribution to GHG emission, and the same is true for the effect of mitigation by reducing GHG emissions.	Rejected - space constraints do not allow to go into the details of every mitigation option. Note that sulphur and particle emissions from coal fired-power plants are not be a given. These emissions might be reduced by end-of.-the-pipe technologies. The energy supply sector discussion has to anticipate this development which is seen in many countries that extend their coal usage.
35263	7	4	43	4	45	There are a lot of unsolved problems about CCS, for instance the high operation cost (100-150$/tCO2, Line 11, page 62), large amount of additional consumption of energy, negative impacts on local environment, and possible carbon leakage. Therefore, the potential of CCS application in the future is still of high uncertainty. Recent studies such as the IEA World Energy Outlook and World Technology Roadmap have all lowered their estimation on CCS potential. In addition, so far there is no large-scale coal-fired CCS project that has been commercialized (Global CCS Institute, 2011). Nor is there any commercialized large-scale CCS project in other industrial sectors (Line 47-48, page 28). Countries including Canada, UK, Germany and USA have all stopped or suspended CCS projects, which reflects the difficulty and uncertainty about CCS. Therefore, it is suggested to indicate all the obstacles and uncertainties of CCS application in this paragraph, instead of just mentioning its mitigation potential.	Taken into account - risks and shortcomings of CCS technologies now are made explicit.
20443	7	4	43	4	44	Recently, a conception of a Carbon Capture and Cycling (CCC) instead a CCS technology was presented for a closed man-made carbon cycle (Möller 2012), see also comment 5. In case of realization of this technology, the present-day CCS may be considered as a bridge technology.	Noted.
20471	7	4	43			"CCS technologies are capable …." should be formulated more cautious like "offer the possibility" or "it is expectated that they will be able…	Noted. The wording in the current draft of chapter 7 adequately expresses the point being made here by the reviewer. The wording of "are capable" is replaced by "may".
20472	7	4	43	5	13	shorten	Accepted - Section 7.5.5 has been shortened and significantly reworked to improve clarity and readability. The treatment of CCS in the ES, however, has not been shorten as many reviewers asked to display potential risks and cost aspects in a more visible way.
19637	7	4	43	4	44	Since full CCS operation has never been demonstrated on a full-scale electricity generation plant, I suggest that this sentence should be ammended to read: "CCS technologies are theoretically capable…and nuclear."	Noted. The wording in the current draft of chapter 7 adequately expresses the point being made here by the reviewer.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19713	7	4	43	4	46	Speaking seriously about BECCS, first of all, one should estimate area of available land to produce bio-fuel and to allow tangible negative CO2 emission. Growing global population should also be taken into account.	Taken into account- Although there is no room in the Executive Summary to get into this level of detail, potential risks associated with BECCS now are mentioned explicitly.
29782	7	4	43		44	Comparing CCS with Renewable and Nuclear is always controversial and debatable. This only distract the importance of CCS as mitigation option for CO2 emissions.	Taken into account - new paragraphs on BECCS emphasize that CCS applied to BECCS might have an important role to play in low stabilization scenarios.
25702	7	4	44	4	45	This part should explain that it is uncertain whether BECCS can be utilized in the future, as described in the section TS.3.3 (page 21, line 37). Safety confirmation, affordability and public acceptance are indispensable in CCS site selection. There is a much higher barrier to adopt BECCS than CCS because BECCS requires stable biomass supply for generation at reasonable cost. Since feasibility for BECCS has not been established so far, it is not appropriate to expect huge potential for BECCS in the future, as described in (Rhodes, 2008, page323). This literature is listed in the No7 line of this table.	Taken into account- Although there is no room in the Executive Summary to get into this level of detail, potential risks associated with BECCS now are mentioned explicitly.
21099	7	4	44	4	45	BECCS is not really discussed in 7.5.5 and 7.8.1. Moreover, the IEA WEO 2011 (p. 235) states about biomass generation with CCS : « this technology is not proven at a commercial scale, and therefore cannot be counted upon ». In addition, the German Academy of Science (Leopoldina) recently issued a report named « Bioenergy, chances and limits », that can be downloaded here http://www.leopoldina.org/en/publications/detailview/?publication[publication]=433&cHash=6828ed4387801f3c1e3ddaa5b636cf40 . This repport is less optimistic than previous IPCC publications on bioenergy mitigation potential. The large uncertainty should be reflected, and mention of BECCS should not be made (e.g. in executive summary or SPM) without explanations on the wide uncertainties affecting it.	Taken into account - a discussion of BECCS now is part of 7.5.5. In addition, BECCS is discussed in the Bioenergy Annex of Chapter 11. The ES now contains two statements on BECCS explaining merits and shortcomings (risks) of this technology.
36704	7	4	44	4	44	Need to define RE - first time use.	Accepted - RE now is defined before the abbreviation is used.
36705	7	4	44	4	44	Add "energy" after "nuclear", i.e., call it nuclear energy rather than just nuclear.	Accepted - text revised.
21113	7	4	46	4	46	CCS technologies are..change to CCS technologies may, as this has not been implemented and fully tested in reality	Accepted - text revised.
21111	7	4	7	4	10	Worth mentioning the impact of the recent economic crisis which I suppose has decreased but not inverted the rate of emissions growth.	Rejected - space constraints do not allow for mentioning all details here.
21770	7	4				Comments on the executive summary are linked to the chapter text on which the executive summary is based. (See sections below for details: 7.1, 7.3, 7.4, 7.5, 7.9, 7.2).	Noted
32989	7	4				The format does not follow the Guidance from the TSU. Please follow for consistency purposes in the final draft.	Accepted - format revised.
35262	7	4	1			In general, the ES is over-optimistic about mitigation cost and potential in the energy sector, and underestimates the difficulties and obstacles. It is suggested to add more discussion on difficulties and obstacles, in particular those related to providing financial support and transferring relevant technologies to developing countries.	Accepted - a new paragraph on developing issues has been introduced in the ES. The respective challenges are dealt with in detail in the extended LDC box in 7.9.1. as well as in 7.10.4.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26900	7	4	1			The order in which energy technologies are discussed in the Executive Summary should be reviewed. Natural gas is presented first and discussed for 4 paragraphs, then CCS for 4 paragraphs, then RE for 2 paragraphs, then nuclear for 4 pargraphs. The ordering and weight given to each technology is at odds with the role of these technologies in mitigating climate change, as substituting natural gas for coal will not be sufficient to meet strict climate targets, e.g. 450 ppm, as discussed later in Chapter 7.	Taken into account - the ordering now follows the ordering in the body text. The number of paragraphs devoted to each option now is more balanced compared to the importance of the respective technology.
20711	7	4	7	4	14	No mention of embedded emissions and their impact on figures given	Accepted - A cross-reference to Chapter 5 now is included.
27049	7	4	25	4	37	Delete (or move to after line 42). The entire executive summary is biased towards gas (and CCS to a lesser extent). A 50% reduction in life-cycle emissions sounds high, but is very low relative to the dozen of other technologies (efficiency, renewables, nuclear etx.) where life-cycle emissions approach 100% compared to coal. Add comparison with these other options to avoid it becoming technology descriptive or delete it. It seems odd to use three paragraphs on one single technology (gas) which the SOD itself determines (in the subsequent paragraph: p. 4 line 38 to 42) has too high emissions to meet the long-term stabilisation targets. Have the technologies come in order of mitigation potential and low emissions (efficiancy, renewables, nuclear, gas coal). At least two, and preferably three of the paragraphs should be removed.	Rejected. No bias can be alleged here, but there is less focus on RE given the recent SRREN. Fuel shifting is a valid mitigation option. The fact that it does not allow to meet low stabilization levels has been and is emphasized in the ES. However, the space devoted to RE is extended and CCS is discussed in a detail necessary to put its prominent role in the scenarios into perspective.
30911	7	4	5	4	6	The time frames used here to compare an acceleration of GHG emissions from the global energy supply sector are not the same, but presumably they should be such that the percent increase is directly comparable.	Taken into account - Annual growth rates are presented across decades. They are now shown for comparable time frames: 1991 - 2000 and 2001 - 2010.
24627	7	4	12	4	13	It is not clear in phrasing what Annex 1 countries have managed to do - please specify whether they have kept emissions reduction levels below 1990 levels each year, or overall	Taken into account - the comment is obsolete as the underlying text has been deleted.
24626	7	4	1	6	45	Suggest this section is introduced by an explanation that the requirement for energy is heavily dependent on the types and scales of services required and the efficiency with which they are delivered. Present developments show that energy efficiency improvement is often far more cost-effective than expansion of energy supply capacity and infrastructure. This could also be better cross-referenced with other chapters of the report. Suggested citations: Goldemberg, J Johansson B, Reddy A and Williams R Energy for a Sustainable World, Wiley eastern New Delhi 1988. Tellus Institute: http://www.tellus.org/programs/integratedscenarios.html Alan K. Pears, Imagining Australia's energy services futures, Futures, Volume 39, Issues 2–3, March–April 2007, Pages 253-271, ISSN 0016-3287, 10.1016/j.futures.2006.01.012. (http://www.sciencedirect.com/science/article/pii/S0016328706000103) Climateworks (2011), 'Low Carbon Growth Plan for Australia 2011 Update. http://www.climateworksaustralia.org/sites/default/files/documents/publications/climateworks_lcgp_australia_2011_update_april2011.pdf	Taken into account - the first statement now contains are pointer to demand side measures. The importance of demand side measures is emphasized in section 7.1 and in 7.11.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
27769	7	40		46		The corresponding part of the SPM (SPM p.21, lines 32-39) reads: " Many climate mitigation options have adverse effects by increasing the cost of energy (high confidence). Approximately 2.6 billion people worldwide (the poor, mostly in developing countries) do not have access to electricity and/or are dependent on traditional use of biomass – burnt in open fires or primitive cookstove designs with severe health implications. Increases in energy costs may impede reaching development objectives related to poverty, such as universal access to modern and clean energy and technologies. Design of climate policies will need thus to account for distributional effects and avoid adverse impacts for the affordability of energy for the impoverished parts of the population. [4.3 6.6, 7.9, 9.8, 11.A.3, 15.7]" Comment: This is an oversimplified if not wrong analysis of costs derived from mitigation options. In contrast, Chapter 7 reads: "The extent of the ... risks will differ greatly across regions, and depend on local circumstances, implementation practices as well as the scale and pace of the deployment of the different options."(Chapter 7, p.43. lines 13-15) In the SPM, it sounds as if the poor are for the most part financially adversely affected by climate mitigation; this is often wrong. Quite often mitigation options reduce energy costs for the poor; in other cases they increase the cost only in the short term but reduce costs in the mid and long term. Chapter 7 reflects this in a more balanced perspective at different places: - Many energy efficiency activities reduce the cost of energy for the poor. - Those 2.6 billion people worldwide who don't have access to the grid are not directly negatively affected by mitigation action in the electricity sector, especially by fuel switch from coal to other fuels. Many of them would benefit from a fuel switch to renewable energy. Chapter 7 expresses this clearly (p. 45 lines 37-39): “In many remote and rural areas, small-scale hydro wind or solar photovoltaic installations are cost-competitive options to increase energy access (Bhuiyan et al., 2000; M Kolhe et 38 al., 2002; Nguyen, 2007; Casillas and D.M. Kammen, 2010; Thiam, 2010)” - But even for the poor connected to the grid, renewable energies are increasingly a cost efficient alternative. "PV module prices, for instance, fell by 55 % since 2009. Bazilian et al. (2012) citing articles by (K. Zweibel, 2010; Breyer and Gerlach, 2010), Branker et al. (2011) and Darling et al. (2011) note that "contrary to the view that the arrival of grid parity is still decades away, numerous studies have concluded that solar PV grid parity has already been achieved in a number of countries/regions". Compared to PV a similar, albeit less extreme trend towards lower LCOE (from 2009 to 2012) has been observed for onshore wind (-13%), land fill gas (-16%), municipal solid waste (-15%), and biomass gasification (-26%)."(Chapter 7, p. 40, lines 11-17). - The same is true for holistic biomass programmes that address the full value chain and have not only the potential "to reduce future GHG emissions. There may also be other co-benefits such as reduced burden of fuel collection, employment, and improved health conditions of the end-users (Owen et al., 2013).(Ch. 7, p. 46, lines 25-28); - "The target of increasing access to modern affordable energy services as part of low carbon strategies has triggered a number of major national programmes (IEA, 2011d; Winkler et al., 2011). With renewables already playing an important role in some of these programmes as well as in smaller local initiatives (ARE, 2011; Gurung et al., 2011; REN21, 2011; Behrens et al., 2012), improvements in energy access do not need to entail significan	Taken into account. Comment refers to the SPM/TS and is considered there.
32825	7	40	11	40	17	What time period covers these percentage changes in LCOE?	Taken into account - the change is from 2009 - 2013.
20493	7	40	11		12	Which module prices fell by 55%? PV silicon module prices have decreased by 60%. Thin film modules have decreasde by 35%. (Bloomberg)	Taken into account - module prices were replaced by PV system prices.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
27069	7	40	13	40	14	Problematic to refer to 'grid parity' a term that is not defined at all. Onshore wind reached 'grid parity 20 years ago (if grid parity is defines as 'lower than retail costa, as is often the case) without it having any significance on cost competitiveness. Do not use the (undefined) term 'grid parity' for one technology (PV) - and certainly not without defining it. 'Grid parity' confuses things and for some strange reason only relates to PV costs in the scientific and public domaine. Use LCOE, also for PV. There is lots of litterature on it. Alternatively, use grid parity for all technologies, if anybody knows how to).	Taken into account - the comment is obsolete as the underlying text has been deleted.
21145	7	40	13	40	14	I'm not familiar with the concept of grid parity. May benefit from a short foot note explanation.	Taken into account - the comment is obsolete as the underlying text has been deleted.
21849	7	40	17	40	23	Negative learning, diseconomies of scale should be explicitly mentioned in addition to the material cost / market competition points mentioned.	Rejected - space constraints do not allow to go into these details here.
26817	7	40	28			Consider for inclusion- Hence, capacity building is especially important, and should target three separate groups: (1) project developers; (2) local finance institutionsl and (3) public officials and administrators, to improve the design and implementation of RE policy. "IRENA (2012), Financial Mechanisms and Investment Frameworks for Renewables in Developing Countries (pg. 22), http://www.irena.org/DocumentDownloads/Publications/IRENA%20report%20-%20Financial%20Mechanisms%20for%20Developing%20Countries.pdf"	Rejected - comment seems to be misplaced.
21848	7	40	7			I don't think peak demand is an energy service. Energy services have some utility to end-users. Peak demand is a consequence of energy services being conincident in time.	Accepted - text revised.
20726	7	40	9	40	23	Again, there is failure to reflect the wide range of results/costs/EROIs resulting from location and related factors. Thus misleading.	Rejected - the used cost data base takes into account the variation of the mentioned factors.
23302	7	40	9		11	Change "changed" to "declined" then add after IPCC AR4 "(Fig. 7.10) and even compared to the SRREN (IPCC, 2011a)". Then delete rest of sentence.	Rejected - changes might include an increase as well.
26841	7	40	10	40	10	I would delete first sentence. This is also true for most renewables, but not mentioned on page 39? Why? Isn't the focus of this section on the costs for new plant	Rejected - the first sentence includes renewable energies. Meaning of the comment is not clear.
24298	7	40	11	40	12	PV module prices are still high (O. Perpiñán, 2012), the international low carbon technology transfer mechanism is needed. It should be added that "but the prices are still high, the international low carbon technology transfer mechanism is needed." after the statement. O. Perpiñán, 2012. Cost of energy and mutual shadows in a two-axis tracking PV system, Renewable Energy,43,331-342.	Taken into account - the necessity for additional support is emphasized in the policy section (7.12).
31537	7	40	11	40	12	PV module prices are still high (O. Perpiñán, 2012), the international low carbon technology transfer mechanism is needed. It should be added that "but the prices are still high, the international low carbon technology transfer mechanism is needed." after the statement. O. Perpiñán, 2012. Cost of energy and mutual shadows in a two-axis tracking PV system, Renewable Energy,43,331-342.	Taken into account - the necessity for additional support is emphasized in the policy section (7.12).
26842	7	40	12	40	14	These risks are similar to those shared by hydropower	Taken into account - comment seems to be misplaced.
26843	7	40	15	40	15	I disagree that the relative economics have deteriorated for nuclear. It is not clear the disaster has any effect on the economics. It does have an impact on the outlook for Nuclear (Whether this is significantly negative remains to be seen) which is very different. The language used makes it suggest Nuclear is relatively economic now, where we have very little evidence of this from liberalised electricity markets	Taken into account - a more balanced wording is used now.
26840	7	40	5	40	5	most project data includes transmission connection costs, so its more the integration costs	Accepted - text revised.
23303	7	41				This is a well used figure- is it needed here? Need to clarify it is PV price not installed so are balance of system costs to add - and these haven't declined so rapidly.	Accepted - figure has been removed due to space constraints.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
40689	7	41				PV should be deleted from Figure 7.11, since cost on the production of PV has been lowering, that on power system stabilization and load fluctuation is the issue.	Taken into account - comment is obsolete as underlying figure has been deleted.
20250	7	41	1	41	9	DELETE PV as it is misleading to plot module costs - now the majority of costs of PV is "balance of systems" which learning rate is much lower.	Taken into account - comment is obsolete as underlying figure has been deleted.
36853	7	41	1			While the purpose of this figure isn't to compare wind and solar cost reductions, such comparisons are likely to be inevitable given that they're shown against one another on the same graph. This is problematic for a couple reasons: First, LCOE is a much more useful comparative metric (the caption does well at least to mention some of the issues associated with using capital costs instead of LCOE). Second, the graph compares the cost of PV modules (not including balance of system or soft costs) with the cost of wind plants (including balance of system and soft costs). That these data are not comparable should be explicit in the caption if the figure is not reconfigured more broadly to draw the distinction	Taken into account - comment is obsolete as underlying figure has been deleted.
36854	7	41	1			**PV cost data is inadequate to support claims and inappropriate for policymaking (includes internal conflict and affects TS p32 and Summary for Policymakers pg 17) Chapter 7 provides multiple claims regarding decreasing PV costs but does not appear to contain relevant data to support this claim. The Second Order Draft PV datasets do not account for the effects of subsidies and do not reflect installed costs. When subsidies and investment (mentioned in 7.10.2) are accounted for, the cost analysis changes dramatically. To what extent are the perceived PV cost reductions a reflection of subsidies? Retail PV module prices may be of some small interest to readers but these nominal costs represent only a fraction of an installed solar system cost. In its current form, the PV cost data neither conforms to generally accepted cost accounting practices for policymaking nor supplies an adequate basis for comparison with conventional baseload power supply. This is especially troubling as this oversight leads to apparently unsubstantiated claims in the Summary for Policymakers, TS, and Executive Summary as well as an apparent internal contradiction within Chapter 7.	Taken into account - comment is obsolete as underlying figure has been deleted.
36855	7	41	1			Please check and update PV prices (lower values have been observed), based on latest available data, e.g., Bloomberg New Energy Finance (BNEF) - http://about.bnef.com/	Taken into account - comment is obsolete as underlying figure has been deleted.
32826	7	41	10	41	11	What is very low? Reference needed.	Taken into account - comment is obsolete as underlying text has been deleted.
20495	7	41	10		11	Delete this first sentence. First of all in view of Climate Change Mitigation effects, only LCOE of new buld plants should be compared. Second, in an number of countries the change of security standards after Fukujima have spurred the need for new investments in old plants. Third, O&M costs of some of the aging power plants in the US are no longer competitive with gas powered plants at the current low gas prices. All this effects are not discussed.	Accepted - text revised.
21850	7	41	10	41	17	Significant cost and time over-runs on the two European EPRs (Finland, France) are worth mentioning in this context as important new information on next generation nuclear designs since AR4.	Accepted - text revised.
21146	7	41	10	41	17	What about the cost of dismantling?	Taken in into account - cost of dismantling is taken into account by the numbers shown in figure 7.7.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36856	7	41	11	41	11	Or plants that require expensive upgrades (e.g. for safety).	Taken into account - comment is obsolete as underlying text has been deleted.
20541	7	41	14	41	17	Should add a new reference to Elliott, D. (2013) Fukushima: Impacts and Implications, Palgrave Macmillan, 145pp. It is not too early evaluatethe impact of the Fukushima accident. This comment also relevant to P28 lines 6-13; and p 41, lines 15-16	Accepted - text revised. The reference, however, is not included as the wording is already balanced.
25719	7	41	16	41	17	This section should be kept in the final version report because it is important to explain that the effects on nuclear plants of Fukushima accident appear to be quite modest at the global level, as described in (Joskow, 2012, page1). <Reference> [1] Joskow, P.L. & J.E. Parsons (2012). The Future of Nuclear Power After Fukushima. MIT Center for Energy and Environmental Policy Research Working Paper 2012-001.	Noted
32827	7	41	17	41	17	What is modest in the context of the original costs? These figures should be reported for completeness and clarity	Taken into account - text revised.
32828	7	41	18	41	24	The sentiments expressed here have been described earlier as part of the extensive CCS discussion. Therefore, they can be omitted from here.	Rejected - this important information is to be expressed here. It is not wrong.
21851	7	41	18	41	24	This seems largely repetitious - delete.	Rejected - this important information is to be expressed here. It is not wrong.
33783	7	41	19	41	20	… to conventional ones. In addition, due to the efficiency loss, additional fuel costs must be incurred (IEA, 2010c) (see Figure 7.10).	Accepted - text revised.
31667	7	41	20	41	22	This may an appropriate point just to note that large scale demonstration is expected to be in place in Canada as a retrofit on one unit of the ageing Skansk Power Boundary Dam plant by late 2015 as this gives an indication when large scale cost data might start to become available.	Rejected - space constraints do not allow to discuss specific projects.
32829	7	41	22	41	22	What is the BAU scenario in this context? Reference needed.	Rejected - comment seems to be misplaced.
29658	7	41	23			The Global CCS Institute should absolutely not be cited in AR5, as it is an advocacy organization.	Taken into account - reference to Global CCS Institute is deleted.
32830	7	41	23	41	27	This paragraph should be combined with the one earlier on this page and consolidated with the earlier discussion on CCS. This would avoid repetition and keep the discussion of CCS as a technology in one place which would help the reader.	Accepted - text revised.
26916	7	41	23			The Global CCS Institute should not be used as a citation, as it is an advocacy organization.	Taken into account - reference to Global CCS Institute is deleted.
21906	7	41	25	42	3	Balancing systems are necessary especially for backing-up electricity generation based on interrmitent rewewables.	Taken into account - This point is made previously in Section 7.6.1: the text was revised previously to make this link more clear.
33052	7	41	25	42	22	Here it would be important to note that the costs presented here are only for variable RE, whereas base-load RE options wouldn't incur an extra cost.	Accepted - Text is revised to make it clear that costs are generally higher for variable RE than for other forms of RE or other mitigation measures

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20251	7	41	25	41	27	Produce summrizin TABLE and KEEP this paragraph regarding sytem integration costs - it is important aspect of RE and needs to be highlighted.	Rejected - A table would simply repeat the information that is already contained in the text and is not necessary given severe space constraints.
23753	7	42	1	42	10	Balancing costs can be negative when there is synergism between different primary energy sources. Example is hydro plus biolectricity from sugar cane waste in some regions of the world.	Rejected - Longer term seasonal variations in resource supply are outside of the definition used here for balancing costs. Though important, these issues are not addressed in this paragraph.
23304	7	42	1		8	Much of this repetition from page 31. Can shorten both and cross-reference.	Rejected -- the overlap is modest, in that this section must address the COST of these infrastructure concerns. Some overlaps are inevitable because, in discussing cost, we have to remind the reader of the issues we are addressing, creating some modest but necessary overlap.
33784	7	42	23	42	27	It is suggested to omit this paragraph	Rejected - The cost of infrastructure for CCS is not covered elsewhere in the document, so it is important to include it here.
21852	7	42	23	42	37	Clarify that the <$15/tCo2 costs are for just the transport and storage components of CCS and exclude the capture component.	Accepted - Text revised
24299	7	42	25	42	26	According to DOE/NETL's research report, the cost for CO2 storage is related to location. In Montana Powder River area, the calculated cost for CO2 storage alone is 17.86$/ton-CO2, plus the cost for CO2 transportation (3.65$/ton-CO2), so the TS&M cost is about 22$/ton-CO2. It is suggested the upper cost range in this sentence be changed to 22$/ton-CO2.——See "DOE/NETL. Updated Cost (June 2011 Basis) for selected Bituminous Baseline cases. 2012. Page 5-6."	Rejected - Text covers total costs for scenarios with CCS, not cost of individual projects. These high costs in some locations may be offset by lower costs in other locations. The text here says "unlikely to exceed" there are papers in the literature that have much higher costs for transporting CO2 over extreme distances. The point here is not to give the full range of potential costs but to summarize the kind of cost that will be seen by the vast majority of CCS installations.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
31538	7	42	25	42	26	According to DOE/NETL's research report, the cost for CO2 storage is related to location. In Montana Powder River area, the calculated cost for CO2 storage alone is 17.86$/ton-CO2, plus the cost for CO2 transportation (3.65$/ton-CO2), so the TS&M cost is about 22$/ton-CO2. It is suggested the upper cost range in this sentence be changed to 22$/ton-CO2.——See "DOE/NETL. Updated Cost (June 2011 Basis) for selected Bituminous Baseline cases. 2012. Page 5-6."	Rejected - Text covers total costs for scenarios with CCS, not cost of individual projects. These high costs in some locations may be offset by lower costs in other locations. The text here says "unlikely to exceed" there are papers in the literature that have much higher costs for transporting CO2 over extreme distances. The point here is not to give the full range of potential costs but to summarize the kind of cost that will be seen by the vast majority of CCS installations.
21148	7	42	30	42	30	Develop briefly why the definition of welfare metrics is problematic	Taken into account. Lack of space and risk of repetition with dedicated discussions in Chapter 3 make such a development not appropriate here. The link to Chapter 3 has been revised and updated to read (See Chapters 3.2.2.6, 3.4.3 and 3.7.1 for a general discussion)
21147	7	42	4	42	4	Do you mean 30% of installed capacity?	Accepted - Text now makes it clear that we mean 30% of annual demand for energy (not 30% of installed capacity).
21854	7	42	41	43	8	This section on MACs is rather weak in being descriptive and not sufficiently critical (there are many problems with MAC driven approaches), and also mainly describing a method rather than the results or findings (which are what is of relevance to this chapter). IAMs using MACs and resource supply curves in mitigation analysis are an obvious source of economic potentials. Can data be included within this section?	Taken into account- For reasons of space and repetition with earlier chapters, all data and broader critiques from this section were removed in earlier drafts. The references to the broader discussion is re-referenced to Chapter 3.8.3 and figure 3.83 respectively
31435	7	42	6	6	43	We propos to add to the sentence, so it reads: "Hence, additional mitigation policies or more stringent use of existing policies must be enacted if the Cancun Agreement is to be fulfilled".	Accepted - seemingly, the comment refers to page 6, line 42-43. There, the text will be revised accordingly.
23754	7	43	10	43	16	I would like to see more discussion on co-benefits, when compared with the space dedicated to extra costs due system integration from different mitigation options.	Taken into account text revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
34326	7	43	10	43	16	Please consider changing the current introductory paragraph to the following wording which will be suggested to each sector chapter to increase consistency and help the reader understand the underlying idea of this section and the links to other parts of the report: "Besides economic cost aspects, the final deployment of mitigation measures will depend on a variety of additional factors, including synergies and trade-offs across mitigation and other policy objectives. Co-benefits, risks and uncertainties associated with alternative mitigation measures and their reliability (7.9.1-7.9.3) as well as public perception thereof (7.9.4) can affect investment decisions, individual behavior as well as priority setting of policymakers. (footnote: Please refer to the respective sections in the framing chapters as well as to the glossary in Annex I for concepts and definitions – particularly 2.2, 3.5.3, and 4.8.2) The extent to which co-benefits and risks actually materialize and their net effect on welfare will differ greatly across regions, and depend on local circumstances, implementation practices as well as the scale and pace of the deployment of the different measures. Table 7.4 provides an overview of the potential co-benefits and risks of the main mitigation measures that are assessed in this section, classified into economic, social (incl equity), and environmental (incl health) effects according to the three sustainable development pillars described in chapter 4."	Taken into account- text revised.
33785	7	43	14			… The extent of the co-benefits …	Accepted - text revised.
19069	7	43	6	43	6	A MAC of up to $100tCO2 seems very high for sequestering wood!	Taken into account. The detailed discussion of MAC curves is outside this chapter's remit and is covered in Chapter 3.8.3. To be clear on this section however, the $100/tCO2 figure as stated is the marginal costs of achieving very significant reductions, and specific mitigation measures that only make up a portion of the abatement will be lower cost
20849	7	44				"Local employment and value added at the place of deployment" is written as one of the RES's social objectives. However, it is not peculiar to RES. Nuclear, CCS(including BECCS) have this feature. This lacks of the balance among zero-emission energy-sources.	Accepted - the most important points are added to table 7.4. The balance of the employment creation section in 7.9.1 has been improved.
25589	7	44				According to NEA/IEA, Projected Costs of Generating Electricity-2010 Edition, the LCOE (5%) of nuclear power is lower than that of coal power in many cases. However, the table describes "increases the cost of electricity generation" for nuclear replacing coal power. This will be inconsistent with the literature. The sentence should be revised.	Accepted. The point has been removed.
31436	7	44				In the column which lists Social (incl equity) co-benefits and risks, it seems odd that "risk of conflicts about the siting" is included for RES and CCS, but not for nuclear. If, however, the above assessment can be justified, we think that it should be considered to limit "risk of conflicts about the siting of storage facilities" to only apply for onshore siting, as conflicts (of significance) about offshore storage are not experienced.	Accepted - text revised.
31437	7	44				Risk of large scale accidents from nuclear power plant is listed under "Social" objectives. We propose that risks from nuclear accidents also is included under the environmental and economic coloumn. "Risk of large- scale accidents with big economic, social and environmental consequenses".	Rejected. The table cannot be comprehensive. It is implicit that risks, benefits or costs in one dimension have effects in other dimensions.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25618	7	44				See comment No.7.	Rejected. Comment is meaningless due to cut reference.
25620	7	44				See comment No.7.	Rejected. Comment is meaningless due to cut reference.
26179	7	44				Please replace nuclear replacing coal power with nuclear replacing fossil fuels. Likewise replace BECCS replacing coal power with BECCS replacing fossil fuels.	Rejected - Here there is a potential for miscommunication. Yes, these technologies can reduce also gas and oil and yield climate benefits, but it is not clear they have the same costs or benefits compared to these.
35391	7	44				Row: RES/Column:Environmental: when it says "excluding biomass" it should be "excluding biomass and waste incineration". Municipal Solid Waste is burnt in incinerators, often as a climate mitigation strategy, as the resulting energy is considered renewable energy in general Renewable Energy policies. However, the air pollution and emissions from waste incineration have been reported and peer-reviewed for their carcinogenic potential. See references: See more references about waste incineration and health: García-Pérez, J. et al., 2013. Cancer mortality in towns in the vicinity of incinerators and installations for the recovery or disposal of hazardous waste. Environment international, 51, pp.31–44. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23160082 [Accessed April 16, 2013]; García-Pérez, J. et al., 2009. Mortality due to lung, laryngeal and bladder cancer in towns lying in the vicinity of combustion installations. The Science of the total environment, 407(8), pp.2593–602. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19187950 [Accessed April 16, 2013]; Medicine, B.S. for E., 2008. The Health Effects of Waste Incinerators 4th Report of the British Society for Ecological Medicine. , (section 8), pp.1–71.; Cheng, H. & Hu, Y., 2010. Curbing dioxin emissions from municipal solid waste incineration in China : Re-thinking about management policies and practices. Environmental Pollution, 158(9), pp.2809–2814. Available at: http://dx.doi.org/10.1016/j.envpol.2010.06.014.. Row: RES/Column:Economics: it should be acknowledged that waste incineration poses a market incentive to burn recyclable materials which have the greatest calorific value - in this sense, the risk is that it would undermine policies pursuing materials efficiency. See references about how the incineration industry makes a lock-in in the flow of materials and undermines initiatives to pursue 3R and zero waste policies. Row: RES/Column:Social: it should mention that incineration of waste competes and displaces the jobs in the recycling sector. Also in the Row of Fugitive methane it should consider co-benefits and risks of landfill gas capture. See reference: UNEP, Waste and Climate Change, 2011.	Rejected. We do not have sufficient space to discuss waste incineration.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
35444	7	44				Row: RES/Column:Environmental: when it says "excluding biomass" it should be "excluding biomass and waste incineration". Municipal Solid Waste is burnt in incinerators, often as a climate mitigation strategy, as the resulting energy is considered renewable energy in general Renewable Energy policies. However, the air pollution and emissions from waste incineration have been reported and peer-reviewed for their carcinogenic potential. See references: See more references about waste incineration and health: García-Pérez, J. et al., 2013. Cancer mortality in towns in the vicinity of incinerators and installations for the recovery or disposal of hazardous waste. Environment international, 51, pp.31–44. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23160082 [Accessed April 16, 2013]; García-Pérez, J. et al., 2009. Mortality due to lung, laryngeal and bladder cancer in towns lying in the vicinity of combustion installations. The Science of the total environment, 407(8), pp.2593–602. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19187950 [Accessed April 16, 2013]; Medicine, B.S. for E., 2008. The Health Effects of Waste Incinerators 4th Report of the British Society for Ecological Medicine. , (section 8), pp.1–71.; Cheng, H. & Hu, Y., 2010. Curbing dioxin emissions from municipal solid waste incineration in China : Re-thinking about management policies and practices. Environmental Pollution, 158(9), pp.2809–2814. Available at: http://dx.doi.org/10.1016/j.envpol.2010.06.014.. Row: RES/Column:Economics: it should be acknowledged that waste incineration poses a market incentive to burn recyclable materials which have the greatest calorific value - in this sense, the risk is that it would undermine policies pursuing materials efficiency. See references about how the incineration industry makes a lock-in in the flow of materials and undermines initiatives to pursue 3R and zero waste policies. Row: RES/Column:Social: it should mention that incineration of waste competes and displaces the jobs in the recycling sector. Also in the Row of Fugitive methane it should consider co-benefits and risks of landfill gas capture. See reference: UNEP, Waste and Climate Change, 2011.	Rejected. We do not have sufficient space to discuss waste incineration.
25720	7	44				In the "Economic" column of "Nuclear replacing coal power" and "RES replacing fossil fuels", the description of Energy security should be revised to "Energy security if fossil fuel power is dominant" because the degree of energy security depends on the constitution of power grid. For example, coal power is necessary to some extent, if coal power is not dominant.	Here there is a potential for miscommunication. Yes, these technologies can reduce also gas and oil and yield climate benefits, but it is not clear they have the same costs or benefits compared to these.
25721	7	44				In the "Economic" column of "Nuclear replacing coal power", the description of Affordability should be deleted completely because the estimated generation cost of nuclear power is generally not higher than that of coal power.	Accepted. The point has been removed
25722	7	44				In the "Social" column of "RES replacing fossil fuels", the description of "Local employment and value added at the place of deployment" should be deleted completely because there is no clear evidence to claim this description and because other kinds of power plants also have same effects.	Accepted - entry deleted.
27070	7	44				Delete: "and unpredictable" in the "Economic" column / Fossil CCS replacing coal row. No renewable energy source is 'unpredictable'.	Accepted - text revised.
31668	7	44		44		Some of the co-benefits and risks apply across more than one impact area. This should be reviewed and if possible cross over items indicated.	Taken into account - where appropriate.
26751	7	44				Same as 6.4	Reject. Comment not comprehensible to us.
26752	7	44				Nuclear power affordability, increases cost of electricity production: Cost of nuclear are quite unclear and it is not certain if cost really increase especially in real terms	Accepted. The point has been removed

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
23746	7	44				Last column of row dealing with Fossil CCS replacing coal should be filled with what is listed for BECCS, last column.	Taken into account.Here there is a potential for miscommunication. Yes, these technologies can reduce also gas and oil and yield climate benefits, but it is not clear they have the same costs or benefits compared to these.
26844	7	44				RES Wind has virtually no impact on wildlife, this is an old issue. Roads and cars are many thousands of times more dangerous.	Rejected. No evidence provided to support this claim.
26845	7	44				RES - economic: least cost electrification solution for rural communities today	Rejected. No evidence provided to support this claim.
26846	7	44				CSP and Hydro – environmental: Can you lump CSP and Hydro together for high water use? More a question of timing of flows and any diversion for hydro, rather than “use” “Supply from variable RES requires extra measures to match demand” this should be more nuanced, “may require depending on the level of penetration…”	Accepted
26797	7	44		44		Other macroeconomic variable, besides employment, monitored in regular bases at least by the Goverments of Germany and Spain, and qith very positive effects are: contribution to the GDP and to the trade balance, few example of this: http://www.bmu.de/fileadmin/bmu-import/files/english/pdf/application/pdf/hg_ausbau_ee_2009_en_bf.pdf http://www.idae.es/index.php/mod.documentos/mem.descarga?file=/documentos_11227_e3_impacto_economico_4666bcd2.pdf Project Economic Value of IRENA is collecting the evidence for macroeconomic impact of large scale RE deployment. We have a review of the literature.	Taken into account. Please note that supply security contributions are already acknowledged.
26798	7	44		44		Other two economic effects: Reduce the risk for price volatility and reduce the price of electricity in countries with a whole sale market for electricity. There are now many empirical evidences. At present, thanks to PV, many days in Germany the highest price is not during peak demand.	Rejected. The evidence from Germany indicates higher price volatility.
26799	7	44		44		Social. Regarding employment IRENA has two reports published one is already quoted in 7.10.4 on RE employment in the framework of access to energy. This fits perfect to support the existing text of the table. http://www.irena.org/DocumentDownloads/Publications/Renewable_Energy_Jobs_and_Access.pdf Second report is an overview of employment for large scale RE electricity generation and liquid biofuels for transport: http://www.irena.org/DocumentDownloads/Publications/RenewableEnergyJobs.pdf A comprenhensive report on RE and employment will be released in June 2013	Taken into account. Please note we do not cite these reports as they are grey literature according to IPCC rules.
26800	7	44		44		Social. The full discusssion on cohesion, social and redistribution effects is missing. Most renewables are developed in rural areas contributing to the development of these areas. Fiscal impacts for small rural municioalities. One exemple: http://www.oecd.org/regional/linkingrenewableenergytoruraldevelopment.htm	Taken into account. Thank you for the reference, which supports the point already made on local value added.
25978	7	44				Table 7.4- its 2nd row has energy sources that are so different (Wind, PV, CSP, hydro, geothermal, biomass), which deserve to be assessed separately for each source.	Taken into account - technologies were singled out where necessary.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21149	7	44				Some info in this table is counterintuitive and may benefit from further explanation e.g. Whay do you assume consequences on affordability from replacing coal power by nuclear if the marginal cost of nuclear is very low. Also, hydro power utilises water but it's not really consumed as water will flow out of the turbines and can be used for other services downstream.	Taken into consideration. Reference to nuclear power cost has been deleted. Water use refers to evaporation, not river flow.
33009	7	44				Table misses a discussion of all options presented in chapter: i.e. improvements to transmission efficiencies, improvements to extraction & conversion efficiencies are missed. Please clarify why they are not included, or alternatively, include them as well.	Taken into account - the options in the other fields have a much lower mitigation capability. Low stabilization scenarios cannot be achieved by only using them. The title "Overview of main GHH emissions mitigation measures" is used to indicate that.
33010	7	44				Social risks of nuclear replacing coal power, would also be environmental risks. E.g. where there are waste disposal risks or accident risks, the ecosystem could also be drastically affected, presenting an environmental risk	Rejected. The table cannot be comprehensive. It is implicit that risks, benefits or costs in one dimension have effects in other dimensions.
33011	7	44				It would be useful to explain the color-coding in the caption (although it is ultimately inferred)	Accepted. Explanation added
23305	7	44				Caption - Change "energy supply sector" to"electricity supply sector".	Rejected - the theme of chapter 7 and the main technologies are defined in 7.1. This cannot always be repeated.
40690	7	44				coal should be replaced by "fossil fuels", because nuclear power plants could replace all fossil fuels.	Here there is a potential for miscommunication. Yes, these technologies can reduce also gas and oil and yield climate benefits, but it is not clear they have the same costs or benefits compared to these.
30543	7	44		46		I am not sure that these page add much and it could be removed	Rejected - this table is the only place where some of the most important co-benefits and risks are summarized in the text.
22601	7	44				this table does not correspond to an equal table in chapter 6 - therefore delete table 6.5	Rejected - every chapter (where this is useful) now contains as similar table and all tables will be combined to a larger one summarizing all co-benefits and risks in the TS.
27770	7	44		44		Line "Fossil CCS replacing coal": Please add in "other" column: Innovation risk, CCS has not yet been applied to a large, commercial fossil fired power plant.	Rejected. The technology is well demonstrated on a demonstration-plant scale and there is no fundamental technical obstacle foreseen to its further scaleup.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
27771	7	44		44		Line "Fossil CCS replacing coal": In the column Economic it says "(but possibly better compared to variable and unpredictable RES)" - why this sudden comparison with RE instead of fossil fuels? This is a diversion from the general methodology for this table, which seems to be a comparison with fossil fuels.	Taken into account - text revised.
27772	7	44		44		Line "Nuclear replacing coal power": The mining for Uranium is accompanied by significant social and environmental costs. This should be added in red.	Accepted. Mining added to list of environmental problems.
27773	7	44		44		Why are all renewable energy supply options put together in one row? A separation of biomass for example would make it much easier to highlight the benefits and drawbacks of this specific technology option.	Accepted - specific technologies are now singled out where appropriate.
27774	7	44		44		Line 'Nuclear replacing coal power', column 'Environmental': Please add (in red): Severe, persistent, widespread damage to health and ecosystems possible in case of radiation leakage or large scale accident.	Rejected. No evidence provided to support this claim.
27775	7	44		44		Line 'Nuclear replacing coal power', column 'Environmental': Please add (in red): Requires large heat sinks (often Rivers), which can affect local ecosystems.	Rejected. The cooling requirements of coal and nuclear power are about the same.
27776	7	44		44		Phasing out fossil fuel subsidies (which are still widely used) should be highlighted as one of the mitigation options in the table. They have a strong influence on costs of electricity e.g. and often influence negatively the economics of climate friendly technology options.	Rejected. The table addresses mitigation options not policy changes.
27777	7	44		44		Line 'RES replacing fossil fuels', column 'economic': language (and red color!) on the affordability should be changed to neutral e.g. "affordability (may reduce or increase cost of electricity generation)". Affordability of and costs for electricity generation depend on e.g. energy markets, local costs of non-renewable energy sources and possible support schemes of RE in place etc. In many places, RE is competitive with fossil fuel supply or even cheaper. In the long term, this is even more evident (rising fossil energy prices and declining RE prices).	Taken into account. Please note that the statement is qualified "in many cases". There were also other changes to the entry.
27778	7	44		44		Line 'RES replacing fossil fuels', column 'Other': The supply of rare earths does not apply to all RES technologies, and can be substituted by alternative technologies (e.g. Wind energy).	Taken into account. Material use now better specified.
27779	7	44		44		Line 'RES replacing fossil fuels', column 'Other': Variable supply of RES, hence the requirement for measures to match supply and demand, is not valid for bio energy and geothermal power.	Taken into consideration. We have modified the text to make sure grid balancing concerns cannot be seen to affect geothermal energy.
27780	7	44		44		Line "Fossil CCS replacing coal": Please add in "other" column: Innovation risk, CCS has not yet been applied to a large, commercial fossil fired power plant.	Rejected. No literature provided to support this claim.
27781	7	44		44		The table is not in accordance with table TS.5 (p. 47) in the TS. Line 'RES', column 'Environmental - Wind': please add impact on landscape ("Wind: impact on wildlife and landscape")	Taken into account - every chapter (where this is useful) now contains as similar table and all tables will be combined to a larger one summarizing all co-benefits and risks in the TS in a consistent way.
27782	7	44		44		The message of table 7.4 seems biased concerning nuclear and fossil energy. Line 'nuclear replacing coal power', column 'Environmental', please add: Health risk due to radioactivity leaks. Moreover, large-scale accidents have disastrous economic and environmental effects and should therefore be mentioned in all three categories. Risk of conflicts about the siting of plants: erase wind (minor part compared to hydro and quite comparable to possible conflicts in case of fossil power plants)	Taken into account. Re. Health risks, see comment 27774. Re. Other effects of accidents, see comment 31437. Regarding siting conflicts, see comment 31436

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26952	7	44				Row: RES/Column:Environmental: when it says "excluding biomass" it should be "excluding biomass and waste incineration". Municipal Solid Waste is burnt in incinerators, often as a climate mitigation strategy, as the resulting energy is considered renewable energy in general Renewable Energy policies. However, the air pollution and emissions from waste incineration have been reported and peer-reviewed for their carcinogenic potential. See references: See more references about waste incineration and health: García-Pérez, J. et al., 2013. Cancer mortality in towns in the vicinity of incinerators and installations for the recovery or disposal of hazardous waste. Environment international, 51, pp.31–44. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23160082 [Accessed April 16, 2013]; García-Pérez, J. et al., 2009. Mortality due to lung, laryngeal and bladder cancer in towns lying in the vicinity of combustion installations. The Science of the total environment, 407(8), pp.2593–602. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19187950 [Accessed April 16, 2013]; Medicine, B.S. for E., 2008. The Health Effects of Waste Incinerators 4th Report of the British Society for Ecological Medicine. , (section 8), pp.1–71.; Cheng, H. & Hu, Y., 2010. Curbing dioxin emissions from municipal solid waste incineration in China : Re-thinking about management policies and practices. Environmental Pollution, 158(9), pp.2809–2814. Available at: http://dx.doi.org/10.1016/j.envpol.2010.06.014.. Row: RES/Column:Economics: it should be acknowledged that waste incineration poses a market incentive to burn recyclable materials which have the greatest calorific value - in this sense, the risk is that it would undermine policies pursuing materials efficiency. See references about how the incineration industry makes a lock-in in the flow of materials and undermines initiatives to pursue 3R and zero waste policies. Row: RES/Column:Social: it should mention that incineration of waste competes and displaces the jobs in the recycling sector. Also in the Row of Fugitive methane it should consider co-benefits and risks of landfill gas capture. See reference: UNEP, Waste and Climate Change, 2011.	Rejected. We do not have sufficient space to discuss waste incineration.
26911	7	44	1			This table, like previous figures, is undermined by the lack of inclusion of conventional generation technologies, which requires a much-needed contextualization. Without knowing the impacts of conventional generation on the four categories considered, it's not clear how much better, if at all, the low carbon technologies are. These technologies should be included and discussed in the table. Another major concern is the negligence of considering natural gas impacts in the table. Indeed, the table simply considers "fugitive methane capture and use or treatment", which should not be included at all if natural gas is not considered. But natural gas should, and indeed must, be considered given the chapter spends significant time explaining the positive impacts of substituting gas for coal. Some less major points: long-term waste disposal has negative environmental effects as well as equity effects in nuclear; and wind also has significant positive impacts on wildlife given that it displaces conventional generation, a point that is not currently made in the table.	Taken into consideration. This table tries to cover a wide ground, but not to be comprehensive. Of course gas is relevant, but since mitigation scenarios do not foresee a large increase in the share of gas in the energy system, we have chosen to not introduce a separate entry of "gas replaces coal". References added to support claims regarding waste.
20727	7	44	1	44	3	Under Nuclear - is this just uranium, or thorium too?	Taken into account. The table refers to uranium.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21855	7	44	1	44	2	As with previous sections, it would be helpful if the full portfolio of mitigation options were included in Table 7.4 and the subsequent co-benefit analysis. Fuel switching is missing as are many issues on the infrastructure side and liquid fuels side; there is also little on the co-benefits (or costs) on distributed generation. RES (and nuclear) affordability is linked to unpriced environmental / CO2 externalities, so important to clarify whether affordability is relative to current (distorted) markets or whether affordability persists with appropriate externality pricing. Table 7.4 should also be consistent in how it treats co-benefits across the options. For example, 'preserving jobs' is cited under fossil CCS, so potential for new jobs needs including under the non-fossil options. Similarly 'innovation risk' is included under BECCS but not under CCS (which is subject to the same core innovation risks as a largely unproven technology at scale). It is also not clear why the lock-in effect is explicitly cited as a co-cost. Certain characteristics of lock-in may be a co-cost, but these should be spelt out. (Lock-in is an adaptive solution in some if not many ways: but more importantly it's a descriptive characteristic of a complex technological system, not inherently a 'cost'	Taken into account. For completeness of options, see 33009. For externalities, see 7.8.2. For innovation risk, see comment 27770. Local employment is included for both RES and Nuclear. I am afraid that we do have space to go into a discussion of lock-in.
36857	7	44	1			Social (column), Fossil CCS (row) - "Preserves fossil industry jobs, infrastructure and investments": This statement, identified (green type) as purely beneficial, might imply negatives (in red) for non-fossil industries. Suggest keeping green but rewording, e.g., "Preserves human capital in the fossil industry, and avoids transaction costs in the reallocation of labor" - unequivocally positive.	Taken into consideration. Please note that the statement has been shortened and edited for brevity
36858	7	44	1			"Environmental, Geothermal: water use and pollution [red]." Sustainable utilization of geothermal resources - injecting all produced fluids into the field or its margins, and relying on air cooling - will neither use groundwater nor generate pollution, if field operations are conducted safely.	Taken into consideration. We have qualified water concerns to "some geothermal".
36859	7	44	1			Under "RES, Environmental, PV" - need to add risks from toxic materials used in manufacture of PV panels. See e.g., http://www.kcet.org/news/rewire/solar/photovoltaic-pv/solar-powers-toxic... & http://grist.org/article/2010-01-06-solars-dirty-little-secret/ & especially http://www.oregon.gov/ODOT/HWY/OIPP/docs/life-cyclehealthandsafetyconcer...	Rejected. We would appreciate peer-reviewed references on a topic and not incomplete URLs. Present LCAs indicate that toxic impacts of coal power are larger than those of PV
36860	7	44	1			(1) BECCS should distinguish itself from Fossil CCS, on energy security objectives: Expanded deployment of BECCS could create bioenergy trade dynamics capable of compromising the security of heavily bio-importing regions (color reversal, relative to Fossil CCS entry). (2) Nuclear, fossil CCS, and BECCS are described as "replacing coal"; this incorrectly (a) rules out their quite possible substitution for other fossil fuels, especially in high-mitigation scenarios, and (b) suggests one-to-one interchange on an unidentified (whether energy, capacity, or other) basis. Recommendation to rephrase - e.g., "displacing fossil fuels" - and move descriptor into caption, to tighten table entries. Same comments apply to Table TS.5.	Taken into account. Here there is a potential misunderstanding. Yes, these technologies can reduce also gas and oil and yield climate benefits, but it is not clear they have the same costs or benefits compared to the ones specified here. The shown costs and benefits refer to a replacement of coal for clarity reasons. There is no space to discuss all permutations.
34371	7	44	1			Please make an attempt to adapt the discussed policy objectives to the wording used in other chapters (such as 'productivity', 'employment creation', 'technology transfer' etc. in place of similar objectives but different wording) to support the effort to facilitate greater synthesis across sectoral assessments in section 6.6.	Taken into account. Please note that employment is already used. The other terms are not found to be appropriate.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19191	7	44	2			In the "Environmental" column of table 7.4 the water consumption of CSP is classified as "high" together with that of hydro, whereas not one of all the other energy supplies receives the same high classification. Consultation of figure 9.14 in reference (4) shows that broadly speaking, the water consumptions of the four CSP technologies cover the same wide range as do the consumptions of all the other technologies, right down to the best cases of near zero. The single exception is that of hydro which soars off-scale by two orders of magnitude. Therefore in my opinion a "high" classification for CSP is unwarranted and should be reserved for hydro only.	Taken into account. Hydropower is listed because it leads to evaporation. Water consumption has been added to CCS.
24649	7	45		45		It is noted that policies for improving energy security focus on adequacy and affordability. Suggest noting that consideration should also be applied to reliability in the context of energy security.	Accepted. This has been reflected in a newly drafted section.
19771	7	45	1	45	9	Positive synergies between reducing emissions and increasing energy security can be added here. For example use of renewables could improve diversity and also decrease import dependence which are both positive for energy security. See relevant references: 1. Michael Grubb, Lucy Butler, Paul Twomey, 2006, "Diversity and security in UK electricity generation: The influence of low-carbon objectives", Energy Policy, Volume 34, Issue 18, Pages 4050-4062. 2. Konstantinos J. Chalvatzis, Elizabeth Hooper, 2009, "Energy security vs. climate change: Theoretical framework development and experience in selected EU electricity markets", Renewable and Sustainable Energy Reviews, Volume 13, Issue 9, Pages 2703-2709.	Accepted. The positive synergies between GHG reduction and energy security has been addressed in the latest draft.
21907	7	45	1	45	9	There are numerous synergies but also trade offs between policies for climate change and energy security.	Rejected. No reference provided
21856	7	45	1	48	14	Apart from the first paragraph, Section 7.9.1 is almost exclusively about energy access (which is a very worthwhile emphasis) but (a) it should be renamed as such, and (b) the critical point in this AR5 context is to discuss the extent to which access is synergistic or antagonistic with mitigation. Here the Global Energy Assessment is the key reference with very timely recent insights. I don't think GEA is cited in this section which is an oversight (e.g., particularly in page 45, line 26-39). More generally, this section should be called something like 'other energy sector challenges'.	Rejected. The section is not just about access but also security. But the main thrust is to highlight that energy is both a driver of socio-economic development and a product of socio-economic conditions.
33881	7	45	10	45	19	A good summary statement and should be transferred to the executive section.	Noted.
25723	7	45	17	45	17	The part of "create local employment and value added" should be deleted completely because there is no clear evidence to claim this description and because other kinds of power plants also have same effects.	Rejected - evidence has been provided in table 7.4.
26801	7	45	17	45	17	I think the word "higher" is not correct I think "large" is more precised. If we are starting from cero we need to do nothing at all to integrate 2% varible electricity.	Accepted
32463	7	45	17	45	19	Renewable energy resources are not technologically stable enough and having higher shares of them do not necessarily improve energy security. Therefore, it should be deleted.	Rejected - reviewer did not produce the evidence that shows otherwise.
36861	7	45	2	45	9	The term "energy security" is out of place, here - most of the criteria described have nothing to do with security.	Reject - the 'security' definition is multifaceted.
34327	7	45	2	45	19	Please liaise with chapter 6.6 and chapter 8 LAs to agree on a common definition for energy security. The lack of a shared definition does not contribute to clarity across the different chapters' assessment. It would also be interesting how unconventional sources might introduce trade-offs between energy security and mitigation (e.g. for Canada). This might involve a restructuring of the section as the current focus on the link between renewables and energy security might have to be given up in favor of a broader discussion.	Accepted - common definition now is used.
21857	7	45	20	45	25	This paragraph (and also Figure 7.12) is very much about energy demand and is not core to the mitigation emphasis in the energy sector. Recommend delete paragpraph and figure. The key argument about developing (vs. developed) countries is the much greater emphasis on capital stock expansion rather than capital stock substitution.	Rejected - the energy access issue relates to future energy systems that will have a bearing on the mitigation agenda.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
34330	7	45	20	45	25	Please expand on the affordability concerns of mitigation measures due to potentially increasing final energy prices. Please consider Jakob and Steckel (2013): How climate change mitigation could harm development in poor countries and related papers.	Accepted - text revised.
34328	7	45	26			Please makes sure if 'efficient' needs to be added to the list (see first sentence after Figure 7.12).	Taken into account - comment is obsolete as underlying text has been deleted.
25943	7	45	27	45	27	...decoupling development from present defective, disorganized and irrational obtention and management of natural ressources, like energy, and hence from carbon emissions…	Rejected - unclear what the reviewer wants.
34329	7	45	29	45	32	Similar numbers are reported in other parts of the report but are slightly diverging (due to different references). A common approach might be more consistent and save space at the same time (e.g. Figure 7.13 might turn out to be unnecessary as it does not improve the understanding of synergies and trade-offs between mitigation and energy access).	Accepted. Maintain consistency.
31669	7	45	31	45	31	How are "modern fuels" defined? The figure referenced suggests that it is everything apart from biomass but presumably it is more specifically foraged biomass? Of at least equal importance must be the method of utilisation of the biomass from whatever source so use of efficient techniques and appliances is also crucial. It would be helpful to note the importance of efficient technology where biomass is used.	Accepted. This has been addressed in the new box 7.1
19070	7	45	32	45	33	"The target of increasing access to modern affordable energy services as part of low carbon strategies has triggered a number of major national programmes". Throughout this section on socio-economic effect, modern fuels and low carbon fuels are frequently mentioned as are the up to 3 million people without access to them. How do you propose to supply this taget population with low-carbon modern energy? Most low-income rural people have access to kerosene and urban low-income people to kerosene, electricity and LPG. However, it is used sparingly because of cost. Rural people need to increase income and promoting renewable carbon energy could be an affordably way. They need some help, but it is probably much cheaper than wind and solar, produced in non-rural aresa and most likely outside the country. And besides, these latter will not supply cooking energy.	Rejected - we are providing a review not new analysis.
20496	7	45	39			Add reference: European Commission, DG Joint Research Centre, The availability of renewable energies in a changing Africa, Edited by Fabio Monforti-Ferrario (forthcoming 2013)	taken into account. Thank you for the reference, but peer-reviewed references were used instead.
33787	7	45	41	46	44	Box 7.1 may be omitted	Rejected - no good reason given for suggested omission.
36862	7	45	50	46	3	Sentence is incomprehensible. Please clarify.	Taken into account - text revised.
20850	7	45	7	45	9	Good text. Coal power is important because popularizing its BAT technologies all over the world contributes not only to GHG emission reduction but also to conserve energy security.	Noted
33786	7	45	9			… increasing dependence on imported natural gas …	Rejected - statement ok as is.
25942	7	45	9	45	9	...(BK Sovacool, 2008), between others.	Rejected - unclear what the reviewer wants.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
35392	7	45				The socio-economic effects of biomass and Municipal Solid Waste incineration have been detailed in the study by Puig, I., Calaf, M. & Mestre, M., 2010. La incineración de residuos en cifras. Análisis soci-económico de la incineración de residuos municipales en España. The report concludes that premiums for incineration are an environmentally damaging and economically important support; the Spanish incinerators have involved an expenditure of about 1,180 million euros, while the average rate and waste inlet is about 65 euros / ton; the consideration of environmental costs would increase incineration costs by over 70%; Waste incineration is a more expensive option for municipalities and citizens than other treatments better placed in the Waste Hierarchy; Plants require 25 workers per 100,000 t of incineration capacity, far less than other treatment options. The conclusions reached for Spain illustrate the reality of incinerators in many countries.	Rejected - not clear what the reviewer is asking.
35445	7	45				The socio-economic effects of biomass and Municipal Solid Waste incineration have been detailed in the study by Puig, I., Calaf, M. & Mestre, M., 2010. La incineración de residuos en cifras. Análisis soci-económico de la incineración de residuos municipales en España. The report concludes that premiums for incineration are an environmentally damaging and economically important support; the Spanish incinerators have involved an expenditure of about 1,180 million euros, while the average rate and waste inlet is about 65 euros / ton; the consideration of environmental costs would increase incineration costs by over 70%; Waste incineration is a more expensive option for municipalities and citizens than other treatments better placed in the Waste Hierarchy; Plants require 25 workers per 100,000 t of incineration capacity, far less than other treatment options. The conclusions reached for Spain illustrate the reality of incinerators in many countries.	Rejected - not clear what the reviewer is asking.
25979	7	45				Section 7-9-1 should include impacts on migration, a great problem of the energy sector that uses land, especially in renewable energies.	Rejected - outside the scope of the chapter.
26953	7	45				The socio-economic effects of biomass and Municipal Solid Waste incineration have been detailed in the specialised literature and should be well reflected in this section. Just to mention a recent study by Puig, I., Calaf, M. & Mestre, M., 2010. La incineración de residuos en cifras. Análisis socio-económico de la incineración de residuos municipales en España. The report concludes that premiums for incineration are an environmentally damaging and an economically important support; the Spanish incinerators have involved an expenditure of about 1,180 million euros, while the average rate and waste inlet is about 65 euros / ton; the consideration of environmental costs would increase incineration costs by over 70%; Waste incineration is a more expensive option for municipalities and citizens than other treatments better placed in the Waste Hierarchy; Plants require 25 workers per 100,000 t of incineration capacity, far less than other treatment options. The conclusions reached for Spain illustrate the reality of incinerators in many countries.	Rejected - not clear what the reviewer is asking.
31438	7	46	15	46	22	It is unclear whether a switch to “non-biomass energy” is a mitigation goal. Please distinguish between different bioenergy sources when describing GHG emission related to biomass combustion. Combustion of bioenergy with a broken or diminished carbon cycle (as by deforestation and forest degradation) will give biogenic carbon the same troublesome characteristics as fossil carbon. However, biogenic carbon emitted and reabsorbed by photosynthesis (with an intact carbon cycle as by sustainable forestry) will not increase the GHG concentration in the atmosphere in a long-term time frame that is relevant for stabilization of the carbon balance. (Article 2 in the Climate Convention).	Take into account. Some of this is covered in the bioenergy annex.
20728	7	46	15	46	19	Box 7.1 offers the opportunity to highlight, and oppose, the burning of palm oil in European power stations. Names to be shamed inlcude members of the UK Planning Inspectorate succh as Alan D. Robinson.	Rejected - outside the scope of the box.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19071	7	46	15	46	18	"The GHG emissions from bioenergy in LDCs, particularly from charcoal sourced from open forests or woody areas are significant – accounting for over 30% of combusted woodfuel in most LDCs (FAO, 16 2011).This trend is likely to continue in view of the fact that biomass will remain an important ource of energy before a significant switch to non-biomass energy is achieved".While they may be significant, they are usually from a renewable source. It is only from a land use change, where the forest area is reduced: this is a salvage operation. If not used the wood will have been burnt in situ. Without increased (rural) income, the people will not be able to afford electricity and fossil fuels, especially for cooking. Surly promotion of renewable biomass for energy purposes is a way to increase carbon storage and provide an energy source nearby. Also, the chapter says that consumption is likely to increase by 2% per year in the next decade!. See Owen et al. Can there be an energy policy in SSA without biomass. Pubilshed in Energy for sustainable development. Feb. 2013. (Cited in Chapter 10). I cannot understand the logic to push for a switch to non-biomass energy!	Accepted. Further clarification has been provided in box 7.1, along the lines of the reviewer.
30109	7	46	15	46	21	Meaning is not clear. Does it mean that charcoal is 30% of woodfuel? Or that bioenergy is 30% of combusted woodfuel (I would have thought it would be 100%)? And what is "this trend"? No trend has been mentioned. The type of GHG emissions should be clarified - as biofuels are carbon neutral, the CO2 emissions do not count, so does the statement refer to black carbon? Or does it imply that the biofuels are not carbon neutral because they are harvested unsustainably, i.e. they are not replaced by new planting?	Rejected. This is referring to open access where replenishment is not actively undertaken. The trend is that 30% of the combusted wood comes from open forests.
23755	7	46	17	46	18	Please, replace "biomass" by "traditional biomass" and replace "non-biomass or to modern biomass".	Accepted
29961	7	46	2	46	2	"only about 71%" sounds a little weird in this context, probably remove "only"	Accepted
27783	7	46	22	46	23	The statement that bioenergy has hardly received attention from governments and the international community is not true in view of the large number of quotas, targets and support schemes. Here, it should be the modernization or efficiency enhancement of traditional biomass use.	Take into account - text revised.
20551	7	46	25	46	29	Add Refs to e.g. The Energy and Resource Institute(TERI) (India) projects to improve efficiency of traditional wood stoves: See Rehman, I H et al (2012) Distribution of improved cook stoves: analysis of field experiments using strategic niche management theory, Sustainability Science (DOI 10.1007/s11625-012-0162-8); and TERI PV lighting project, to replace kerosene lighting with PV lights. Ref: TERI (2011) 'Lighting a Billion Lives' http/labl.teri.in	Rejected. The specific problems of biomass are addressed in Annex 11.A. thank you for the references.See comment 19073
30111	7	46	3			Presumably should read "cooking and heating"?	Noted. Text has been changed.
36863	7	46	37	46	37	"In pursuing low carbon development pathway": insert "a" after "pursuing"	Accepted
27784	7	46	37	46	44	Preconditions to tapping the RE potentials in LDC are not only capital and the like, but also a safeguard against an exploitation of the finite potentials by high demanding and financially much stronger countries. In terms of sustainable development rich countries should take into account and respect local energy needs (largely with Renewables) when larger import/ export deals on energy carriers are to be established - which is true especially in the case of bioenergy carriers.	Rejected. Outside the scope of the chapter. Some of this issue is covered in the framing chapter.
30112	7	46	41	46	42	What does "intensity-derived factor scarcities" mean? I understand "factor scarcities" in the context of the previous line, but not "intensity-derived". Suggest you either explain what it means or leave it out.	Take into account - aim to clarify reviewer's question
32831	7	47		47		The data points and best-fit lines reflect different years of HDI analyses? If so, this should be made more clear.	Taken into account. Comment is obsolete; Figure 7.12 has been deleted.
34506	7	47		48		The figure is not highlighting the necessary projections. Need complete redrawing with weights and different color schemes	Taken into account. Comment is obsolete; Figure 7.12 has been deleted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21150	7	47				Too small, difficult to read	Taken into account. Comment is obsolete; Figure 7.12 has been deleted.
33053	7	47		48	14	Both figures and most of the text here is covered in other chapters and would therefore be a great opportunity to shorten the chapter, and also improve consistency with other chapters. Please refer to the numbers presented in the framing chapters (particularly Chapter 4), and reduce this text accordingly.	Taken into account. Cross-reference with other chapters.
36864	7	47	1			This figure begs to have another figure or a chart of primary energy vs. per capita carbon emissions. Suggest adding one.	Taken into account. Comment is obsolete; Figure 7.12 has been deleted.
26820	7	47	10			Consider for inclusion- Small-scale renewable energy technologies are well adapted to the rural context as the bulk of the skills and training required for their deployment can be developed locally. This limits the need for developing countries to rely on foreign know-how and expertise. "IRENA (2012), Renewable Energy Jobs & Access (pg. 11), http://www.irena.org/DocumentDownloads/Publications/Renewable_Energy_Jobs_and_Access.pdf"	Rejected. This is not universally true. However, the section has been re-drafted to capture the employment co-benefits from renewables.
36866	7	47	12	47	12	It appears that A. Riahi should be K. Riahi here and that there is a double reference in the back.	Accepted.
21209	7	47	40			Change to "fulfillment"	Noted.
21210	7	47	44			Add full stop i.e. "p. S83)."	Noted.
26802	7	47	5	47	7	http://www.irena.org/DocumentDownloads/Publications/Renewable_Energy_Jobs_and_Access.pdf	Taken into account The employment co-benefits have been reflected in a re-written section
34331	7	47	5	47	17	Please integrate the findings of this paragraph into the existing structure or delete redundant information (such as the first sentence and the findings on household cooking that rather belong to chapter 9 and/or into the LDC Box).	Take into account - text revised considerably.
36865	7	47	7	47	7	Should nuclear be included in addtion to RE since the topic is GHG mitigation?	Rejected - this section is about energy services for development. There is ample discussion on nuclear in other sections.
19072	7	48				What is wrong with 2.663 billion people being dependent on biomass for cooking?. The inference from this statement is that biomass is BAD. However, it is available and cheap and is a renewable oxygentated carbon fue (excluding charcoal). The number may be over 3 billion when people use mixture of fuels including biomass. And all animals depend on 'carbon-based fuels' to live!	Taken into account. Comment is obsolete; Figure 7.13 has been deleted.
32832	7	48	15	48	23	The points made here have been presented before.	Rejected. Comment is unclear. Where have these points been presented before? Where?
36867	7	48	15	49	42	Section 7.9.2 could be condensed significantly. More importantly, it should be made more coherent. In its present form it is hard to understand.	Editorial
34332	7	48	31			Please consider adding "as well as the associated health" after 'environmental'.	Accepted. Text has been revised
32833	7	48	32	48	35	2.5 million pre-mature deaths over what time period and location?	Accepted. Per year
19772	7	48	32	49	2	From a policy point of view the non-GHGs environmental impact of combustion should refer to the issue facing Europe with shutting down of old coal power plants and the implications that this has for energy supply security. At least the relevant directive could be mentioned 2001/80/EC. Also the US Clean Air Act that regulated for the emissions trade of sulphur and nitrogen oxides.	Editorial. Policy is not addressed in this section

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21908	7	48	32	48	39	The power sector is responsible not only for CO2 emissions but also for emission of sulphur and nitrogen oxides. These emissions are regulated and because of them several coal-fired power stations already had to reduce their annual operation or even shut down. This has a positive impact on reducing CO2 intensity because these are usually some of the oldest, least efficient power plants.	Taken into account.
20459	7	48	32	48	41	Recommend including a discussion of the health effects associated with burning biomass/biofuels, particularly as it relates to indoor air pollution effects in the developing world.	Rejected. The issue of the use of bioenergy in households is covered in chapter 10.
23604	7	48	34	48	34	"causing on the order of 2.5 million premature deaths for outdoor air pollution" per year ?	Accepted - text revised.
25621	7	48	40	49	1	Nox and Sox ,dust removal technologies for coal power plant have already been established so there are no big difference of condition between coal power and others. "especially coal combustion" should be deleted.	Taken into account. Even with state of the art pollution control, emission of these pollutants are clearly higher for coal than for other power sources. This has now been specified.
25724	7	48	40	49	2	This part should be deleted completely because generation facility that has impacts on human health and ecosystem is not only coal fired power plant. For example, wind power plant has also impact on the environment. Therefore, it is not appropriate to mention only about coal combustion. In addition, SOx/NOx emission can be technically decontaminated by installing SOx/NOx removal equipments into coal power plants, as shown in (Margaret, 2005, page369-370, Fig9) and (Sonia, 2005, page3 and 6). These literatures are listed in the No53 line of this table.	Taken into account. Even with state of the art pollution control, emission of these pollutants are higher for coal than for other power sources. This has now been specified.
32464	7	48	40	49	2	It should be deleted because the risks related to health and ecosystem are not exclusive to coal combustion but common to any kind of energy use.	Rejected. The statement is well supported by the literature cited. Please note that ecological impacts of RE are discussed in the following paragraph.
26870	7	48	19	48	19	It might be worthwhile specifying that for wind, solar and tidal this issue does not apply as they can never exceed their regenaration rate.	Taken into account. This is exactly what the sentence says.
35393	7	48				Health effects of biomass and waste incineration have been reported as carcinogenic in extensive literature. See some basic reference here: See more references about waste incineration and health: García-Pérez, J. et al., 2013. Cancer mortality in towns in the vicinity of incinerators and installations for the recovery or disposal of hazardous waste. Environment international, 51, pp.31–44. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23160082 [Accessed April 16, 2013]; García-Pérez, J. et al., 2009. Mortality due to lung, laryngeal and bladder cancer in towns lying in the vicinity of combustion installations. The Science of the total environment, 407(8), pp.2593–602. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19187950 [Accessed April 16, 2013]; Medicine, B.S. for E., 2008. The Health Effects of Waste Incinerators 4th Report of the British Society for Ecological Medicine. , (section 8), pp.1–71.; Cheng, H. & Hu, Y., 2010. Curbing dioxin emissions from municipal solid waste incineration in China : Re-thinking about management policies and practices. Environmental Pollution, 158(9), pp.2809–2814. Available at: http://dx.doi.org/10.1016/j.envpol.2010.06.014..	Taken into account. Please note that we do not have the space here to evaluate individual epidemiological studies but rather refer to higher-level assessments of the issue by WHO and similar bodies.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
35446	7	48				Health effects of biomass and waste incineration have been reported as carcinogenic in extensive literature. See some basic reference here: See more references about waste incineration and health: García-Pérez, J. et al., 2013. Cancer mortality in towns in the vicinity of incinerators and installations for the recovery or disposal of hazardous waste. Environment international, 51, pp.31–44. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23160082 [Accessed April 16, 2013]; García-Pérez, J. et al., 2009. Mortality due to lung, laryngeal and bladder cancer in towns lying in the vicinity of combustion installations. The Science of the total environment, 407(8), pp.2593–602. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19187950 [Accessed April 16, 2013]; Medicine, B.S. for E., 2008. The Health Effects of Waste Incinerators 4th Report of the British Society for Ecological Medicine. , (section 8), pp.1–71.; Cheng, H. & Hu, Y., 2010. Curbing dioxin emissions from municipal solid waste incineration in China : Re-thinking about management policies and practices. Environmental Pollution, 158(9), pp.2809–2814. Available at: http://dx.doi.org/10.1016/j.envpol.2010.06.014..	Taken into account. Please note that we do not have the space here to evaluate individual epidemiological studies but rather refer to higher-level assessments of the issue by WHO and similar bodies.
33054	7	48				Why are the environmental and health risks of nuclear missing? Both could be impacted by accidents and/or waste disposal.	Rejected. Accidents are treated in 7.9.3. Routine operations cause little impact except in the minining phase, and there is little documentation in the literature we have reviewed.
26954	7	48				Health effects of biomass and waste incineration have been reported as carcinogenic in extensive literature. See some basic reference here: García-Pérez, J. et al., 2013. Cancer mortality in towns in the vicinity of incinerators and installations for the recovery or disposal of hazardous waste. Environment international, 51, pp.31–44. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23160082 [Accessed April 16, 2013]; García-Pérez, J. et al., 2009. Mortality due to lung, laryngeal and bladder cancer in towns lying in the vicinity of combustion installations. The Science of the total environment, 407(8), pp.2593–602. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19187950 [Accessed April 16, 2013]; Medicine, B.S. for E., 2008. The Health Effects of Waste Incinerators 4th Report of the British Society for Ecological Medicine. , (section 8), pp.1–71.; Cheng, H. & Hu, Y., 2010. Curbing dioxin emissions from municipal solid waste incineration in China : Re-thinking about management policies and practices. Environmental Pollution, 158(9), pp.2809–2814. Available at: http://dx.doi.org/10.1016/j.envpol.2010.06.014..	Taken into account. Please note that we do not have the space here to evaluate individual epidemiological studies but rather refer to higher-level assessments of the issue by WHO and similar bodies.
34333	7	48	15			The increased water requirements from solar thermal electricity generation are mentioned twice (page 49, lines 14 and 35). Please add information about some of these effects in a baselines scenarios (such as for bats, see Sovacool (2009) and Willis et al. (2010).	Taken into account. The discussion of water use has been modified and the one on bat and bird shortened.
24300	7	48	32	49	2	The sulphur and nitrogen oxides from the coal combustion can be mitigated technically(Todd H. Gardner et al 2002). It should be added that "The sulphur and nitrogen oxides from the coal combustion can be mitigated technically." after the statement.Todd H. Gardner,David A. Berry,K. David Lyons,Stephen K. Beer,Adam D. Freed, 2002. Fuel processor integrated H2S catalytic partial oxidation technology for sulfur removal in fuel cell power plants. Fuel, 81, 2157–2166.	Accepted. Text added to specify that we compare modern plants with state-of-the-art pollution control to renewable facilities.
31539	7	48	32	49	2	The sulphur and nitrogen oxides from the coal combustion can be mitigated technically(Todd H. Gardner et al 2002). It should be added that "The sulphur and nitrogen oxides from the coal combustion can be mitigated technically." after the statement.Todd H. Gardner,David A. Berry,K. David Lyons,Stephen K. Beer,Adam D. Freed, 2002. Fuel processor integrated H2S catalytic partial oxidation technology for sulfur removal in fuel cell power plants. Fuel, 81, 2157–2166.	Accepted. Text added to specify that we compare modern plants with state-of-the-art pollution control to renewable facilities. see comment 24300

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36870	7	49	13	49	15	"Geothermal energy (Bayer et al., 2013)...have high water requirements and cause potential concerns about water pollution, depending on design and technological choices." If sustainable production is utilized with all geothermal fluid injected and air cooling, water use and pollution are greatly mitigated as well as maintain reservoir longevity.	Rejected. There is not enough space to explain details here, but they are provided in the references cited. The text provides an adequate summary, appropriately qualified. Please note that reinjection does not solve the need for a lot of cooling water.
33788	7	49	14			… and geothermal power causes …	Noted. Text has been changed.
25946	7	49	15	49	15	...depending on design and technological choices, but these risks can be avoided through technological improvements, when they are related to a RES integral design and use.	Taken into account. This is exactly what the paragraph says. See preceeding sentence.
20730	7	49	16	49	20	How are 'pollution-related indicators' defined? Hydro schemes that can disrupt the lives and occupations of thousands? Large wind turbines that have powerful visual impacts? Siiting of wind turbines so that they have detrimental impacts on residential property prices (not compensated for) or through aerodynamic modulation adverse impacts on sleep and health? Large-scale solar schemes?	Taken into account. Please note that land use, habitat change or visual impact are not defined as pollution. Pollution relates to emissions.
31670	7	49	16	49	20	This paragraph needs to be edited to improve clarity. One specific question is what is meant by "per unit of electricity produced". Is this intended to be; the rated output, the rated output moderated by availability, or, total lifetime output generated?	Accepted. The paragraph has been replaced with a longer and more specific discussion.
19645	7	49	16	49	16	Spelling: favourably (not 'favourable')	Editorial
25947	7	49	17	49	17	...on traditional pollution-related indicators.	Editorial
32834	7	49	21	49	29	The points made here have been presented before.	Editorial. The reviewer has not identified where this has been made before, apart from the cited publications.
21858	7	49	25	49	26	This is an interesting counterfactual statement about avoided impacts relative to impacts. It is made about CCS, but it is a far far wider point about all the mitigation options (potentially). So, this is another example of asymmetries within the coverage of different mitigation options (and the tendency to over-egg the CCS pudding). It is important to provide a balanced treatment of the mitigation options in argument, coverage and detail.	Taken into account. Please note that the discussion of the environmental impacts of renewable options has been expanded
25948	7	49	25	49	27	...(Singh, et al., 2011). Uncertainties and risks…	Editorial
20729	7	49	3	49	20	Estuarine barrages are worth mentioning here: La Rance which "destroyed the local ecology" [EdF]; Canada has shut down Annapolis and not proceeded with Cumberland and Minas Basins; despite potential impacts on over-wintering and migratory birds, some still seek to build across various UK estuaries.	Rejected. These barriers are not expected to play a substantial role in any of the transformations scenarios. For issues to be considered, they need to be supported by peer-reviewed literature.
19073	7	49	3	49	3	Technical risks. For biomass the technical risks are choice of wrong species, poor tools, insufficient traning. There are also climatic risks and fire potential.	Rejected. The specific problems of biomass are addressed in Annex 11.A
32835	7	49	36	49	37	How much is efficiency decreased and costs increased for air cooling?	Editorial. Text has been condensed and this is now longer relevant.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24405	7	49	36	49	37	"Air cooling systems reduce water use substantially but decrease efficiency and increase costs." This should be quantified. For a parabolic trough CSP plant, air cooling instead of water cooling will increase the levelized electricity cost by between 5 and 8%, depending on location. (See Turchi, C., M. Wagner, and C. Kutscher. "Water Use in Parabolic Trough Power Plants: Summary Results from WorleyParsons' Analyses," 108 pp. NREL Report TP-5500-49468, 2010 and Wagner, M. and C. Kutscher. "Assessing the Impact of Heat Rejection Technology on CSP Plant Revenue." Proceedings of the 2010 SolarPACES Annual Conference, Perpignan, France, September 2010.) For power towers, which operate at higher power cycle temperatures and thermodynamic efficiencies, the cost impact would be less.	Rejected. The specific problems of biomass are addressed in Annex 11.A. thank you for the references.See comment 19073
31671	7	49	37	49	37	Relative to water systems where water is available but where water availability is low the costs of accessing it will be high. In such locations ary cooling systems can be more cost effective.	Taken into account. However, space constraints prevent us from a detailed discussion.
32836	7	49	38	49	42	This paragraph can be omitted as the points have been expressed in an earlier part of the Chapter.	Accepted.
20460	7	49	38	49	42	Unclear why the environmental performance for fossil technologies is expected to decline in the future. Burnham (2012) showed that emissions from unconventional gas were actually less than emissions from conventional gas, and in general one would expect improving efficiencies and environmental performance going into the future from improvements in technology and practices.	Taken into account. Text deleted in response to 32836
21859	7	49	43	50	47	Much of this section has extraneous detail (e.g., page 50, line 9-28) or is repetitious (particularly the material on nuclear safety). Figure 7.14 provides a nice synthesis; the rest of the human safety details can be dramatically shortened.	Noted. Text has been changed.
21909	7	49	43	51	27	In the energy sector, like in every other large-scale industrial sector, there are numerous technical risks, including risk for fatalities etc.	Taken into account.
30544	7	49	44	49	48	Not sure the statements on acccidents help much and could be removed	Noted. Text has been changed.
23756	7	49	5	49	6	RE uses large areas but for some end-uses the area extension can be modest. See Pacca, S. and J. R. Moreira, 2011. A Biorefinery for Mobility? Environ Sci Technol. 2011 Nov 15;45(22):9498-505. .	Rejected. Mobility issues are covered in Ch.8
36868	7	49	5	49	8	The statement that renewable energy "often" has greater ecological impacts than fossil fuel based systems is an extremely strong statement and one that is not well-supported here or in the referenced SRREN. While (for example) a wind farm may be spread out over many square miles, its footprint in terms of physical habitat disturbance will actually be only a small percentage of that area. Further, on a lifecycle basis, fossil fuels present multiple ecological impacts that complicate the picture: physical land disturbance and other impacts associated with the extraction and transport of fuel stocks, ecological impacts of pollutants such as SOx, NOx, mercury, and climate change impacts associated with the release of GHGs either at the smokestack or at other points in the lifecycle (for example, methane release associated with hydraulic fracturing). It is fine to say that renewable energy deployment may require large areas of land, but to say that the land area requirements make the ecological impact of these technologies greater than fossil fuels is both unsupported here and inaccurate. Suggest that at a minimum, the comparative should be removed.	Rejected. The review statement is a gross misrepresentation of what is being said in the text. The text points out that habitat change is often greater than in the case of fossil technologies. "Often" is used intentionally as to imply more than occasionally but not always.
25944	7	49	5	49	5	Some of the renewable energy sources…	Rejected. All renewable energy sources have, in many cases, a relatively low energy density. Run of the river hydro can be an exception.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36869	7	49	8	49	10	Barotrauma - referred to here as "wake-induced damage to bats" - is a hypothesis that has not been well-established and remains extremely controversial. Recent (and as yet unpublished) modeling at NREL suggests that pressure differentials near moving wind turbine blades are insufficient to cause fatal injuries to bats. Given that bat collisions are well-documented as a source of mortality and a potentially significant impact regardless of whether barotrauma is an issue, it would be more accurate to say that "For wind power plants, collisions with raptors and bats..." and strike "wake-induced damage".	Accepted. Thank you for pointing out this new research.
24404	7	49	9	49	9	This refers to "wake-induced damage to bats." See http://www.nrel.gov/wind/news/2013/2149.html, which concludes, "Considering that the pressure changes around wind turbine blades at low wind speeds are insignificant and that there are few bat deaths at higher wind speeds, it seems unlikely that barotrauma is a significant cause of bat fatalities around wind turbines, and that the vast majority of bat fatalities are a result of blade strikes."	Accepted. Thank you for pointing out this new research.
25945	7	49	9	49	9	...during construction, can cause…	Noted - comment does not indicate a change to be made.
26872	7	49	19	49	20	wind energy's pay-back is usually less than 6 months.	Taken into account. What we write here is not in contradiction to this fact and is in fact based on studies that also can be used to confirm the reviewer's claim.
26871	7	49	3	49	10	It seems inappropriate to bundle all RE technologies in the same paragraph as their land footprints are different and, certainly, wind's land footprint is not an issue. Moreover, with appropriate impact assessments and, if required, mitigation/habitat recreation measures, wind energy's impact on fauna and flora is significantly less than what the current wording suggests.	Rejected. Wind power has a substantial land footprint if the entire wind park or the area of bird/bat habitat affected is considered. Of course, it has less impact on flora than other sources.
29559	7	49	12	49	12	Insert this sentence at line 12, after "….Lucas et al., 2012). For photovoltaic power plants, Desideri et al., 2012 show that the environmental impact of this renewable energy system is smaller in comparison with traditional energy systems fossil fuel based. Considering the assembly stage, the main environmental impact is associated with the production, transport and installation of photovoltaic modules, but also electrical materials and the wiring phase have an important role in terms of impact. For Hydropower plants,...."- Additional reference full citation: U. Desideri, S. Proietti, F. Zepparelli, P. Sdringola, S. Bini, Life Cycle Assessment of a ground-mounted 1778 kWp photovoltaic plant and comparison with traditional energy production systems, APPLIED ENERGY n. 97. pg. 930-943 Elsevier Journal (2012)	Rejected. The life cycle inventory of the paper in question is not published. It uses the ecoindicator 99 endpoint method in a manner that it is hard to trace this assertion.
19773	7	49	43			Although that is an interesting section it should be considered for removal since it is, in essence, not strongly relevant climate change. This comment assumes that there is a request to reduce the size of this chapter.	Rejected. Section was requested in the approved outline.
24650	7	49	43	51	27	This section sets out important concepts and research - please keep if shortening the chapter	Accepted.
26094	7	49	44	51	27	illegibility of data and the comment is to long	Taken into account. The figure has been removed.
23250	7	5	10			add: "… and legal liabilities"	Rejected - space constraints do not allow to consider every detail.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25704	7	5	11	5	12	This part should be kept in the final version report and also explain that CCS projects should be implemented preferentially from the verified sites where safety and economic feasibility are confirmed. Insufficient verification causes a large amount of social and economic damages.	Taken into account - as many reviewers have asked for a reduction of the space devoted to CCS this part has been deleted.
30065	7	5	11	5	13	I do not agree!	Noted - reviewer comments can only be handled if they are supported by arguments.
36709	7	5	12	5	12	On total practical geologic storage capacity for CO2: it is implied here and in 7.5.3 that "geographically unevenly distributed" has consequences for the cost of sequestration and that capacity may not be located where it is most needed. If this is the intent, it should be made more explicit. The finding here should also be better reflected in the text section.	Taken into account - as many reviewers have asked for a reduction of the space devoted to CCS this part has been deleted. The comment therefore is obsolete.
34157	7	5	14			The comparison to SRREN might be useful because a lot of issues in this chapter are up-dates of this report that was published between AR4 and AR5.	Accepted - a cross-consistency check was carried out.
35384	7	5	14		21	The paragraph should be included the appropriate technology and the advancements in Anaerobic Digestion methods. Simple Anaerobic Digestion plant to process organic wastes already implemented widely and proven applicable in India. Reference: GAIA, 2012. On the road to Zero Waste Successes and LessonS from around the World.	Rejected - space constraints do not allow us to provide every good example here.
35437	7	5	14		21	The should be an included mention of the advancements in Anaerobic Digestion.	Rejected - space constraints do not allow us to provide every good example here.
20712	7	5	14	7	24	Makes it appear so easy! What about power densities; EROIs; 'useful energy'; location, investment requirements?	Rejected - relevant barriers are addressed elsewhere in Chapter 7, and even the ES; these paragraphs are intended to only discuss technical advancements since AR4, and the technical potential. Barriers such as costs, infrastructure, etc are addressed in other paragraphs.
24399	7	5	14	5	16	You say one of the reasons for the reduction of PV module price is increased efficiency. You should clarify then that you are specifying the price in terms of dollars per peak watt.	Taken into account - text removed/revised to make this comment moot.
26791	7	5	14	5	21	"couple" CSP plants are opearing at present in at least 11 countries: http://www.estelasolar.eu/fileadmin/ESTELAdocs/documents/Publications/ESTELA-Position_Paper_FINAL_JAn2013_double_page.pdf Please contact Mr. Luis Crespo (lcr@estelasolar.eu) for recent accuarte data	Accepted - revisions in body of report made to clarify text; actual text in ES removed, making the point moot in ES.
33871	7	5	14	5	21	Please include a sentence or two about geothermal; all other renewables are mentioned. Geothermal energy is clean, renewable, baseload, flexible and distributed.	Rejected - space constraints required that we eliminate text, so we cannot accommodate a geothermal specific sentence here, and in fact, we have eliminated many of the previous RE technology specific sentences for similar space reasons.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
23251	7	5	14	5	24	Is nothing here on heat.	Rejected - Biomass is noted throughout the Chapter, which includes heat. We do not have the space for comprehensiveness here, and technical advancements since AR4 in RE heating have been relatively limited. Moreover, biomass heating is only relevant to Ch 7 if used as district heating (a small portion of overall heating), as otherwise it should be found in the end-use chapter (especially in the buildings chapter).
20247	7	5	14	5	21	INSERT A SECTION that there is a heated debate over the RE diffusion by subsidies - regarding costs, environemntal effectiviness, intermittency and associated back up costs. See Frondel (2010) for example.	Rejected - the ES is not the place where "heated debates" are to be displayed. The merits and shortcomings (e.g. higher costs of RE, environmental impacts, and integration issues) are explicitly addressed in the ES. The work of Frondel is cited in the body text.
40685	7	5	14	5	20	Regarding the enhanced introduction of renewable energies, it should be clearly described that the back-up cost in many countries is getting higher.	Taken into account - this point is addressed in the chapter (7.6.1), and the possibility of increased costs as a result of RE integration is mentioned in the ES.
26945	7	5	14		21	The should be an included mention of the advancements in Anaerobic Digestion, which provides a mitigation option to organic waste in landfills.	Rejected - space constraints do not allow us to provide every good example here.
25161	7	5	14	5	16	Advise complete rewrite. See Comment on Chapter 7 entitled: **PV cost data inadequate to support claims and inappropriate for policymaking (includes internal conflict and affects Technical Summary p32 and Summary for Policymakers pg 17)	Accepted, in part - see response to earlier comment
36710	7	5	16	5	16	Use "PV" only since "photovoltaic was defined a few lines earlier.	Accepted
26899	7	5	22	5	24	In Chapter 7, many studies are presented on both sides of the debate on whether the global technical potential of RE is limited. That discussion does not conclude one way or the other. Yet, here in the SPM, it is stated without hedging that there is no practical constraint from technical potential on REs. This sentence should be revised to reflect the uncertainty in this debate.	Accepted -Taken into account with revised text

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
35385	7	5	22		24	Include 'with the exception of biomass/waste that poses a constraint to mitigation through materials efficiency strategies. This sentence is important including to make a reference to the lock-in posed by the biomass/waste incinerators, that will prevent material efficiency strategies for a long period of time, as incinerator usually take up contracts for 30-40 years to compensate the heavy initial investments needed. This example should be included in this section for the widespread and increasingly important presence of this industry in developing countries where there is a risk to reproduce the problems of overcapacity faced in developed countries. In the case of incinerators, the generalised lock-in has created a situation of incineration overcapacity -more capacity to burn than waste is or will be available-, with at least 80% of MSW being recyclable. Reference: Altair, 2013, Characterisation of households residual fraction in Gipuzkoa, Spain. Building incineration capacity to burn more than 20% of the waste available is locking in waste prevention and recycling policies in the future. A recent study proves how this lock-in effect in place ssuch as Denmark, Sweden, Germany or Holland is threatening recycling and encouraging the shipment of waste that otherwise could be treated locally with less environmental cost. Reference: Jofra M., Ventosa I., 2013 "Incineration overcapacity and waste shipping in Europe: the end of the proximity principle?". This concern has also been reported in Greater Manchester, at the time of a thorough revision of the waste management system to foster material efficiency strategies. Reference: Uyarra, E. & Gee, S., 2012. Transforming urban waste into sustainable material and energy usage: the case of Greater Manchester (UK). Journal of Cleaner Production, pp.1–10. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0959652612006403 [Accessed January 30, 2013].	Rejected - this level of detail simply is not possible given space constraints in the ES; note also that MSW issues are addresses in the industry sector chapter of AR5, not in Chapter 7.
35438	7	5	22		24	Include 'with the exception of biomass/waste that poses a constraint to mitigation through materials efficiency strategies. This sentence is important including to make a reference to the lock-in posed by the biomass/waste incinerators, that will prevent material efficiency strategies for a long period of time, as incinerator ususally take up contracts for 30-40 years to compensate the heavy initial investments needed. This example should be included in this section for the widespread and increasingly important presence of this industry in developing countries where there is a risk to reproduce the problems of overcapacity faced in developed countries. In the case of incinerators, the generalised lock-in has created a situation of incineration overcapacity -more capacity to burn than waste is or will be available-, with at least 80% of MSW being recyclable. Reference: Altair, 2013, Characterisation of households residual fraction in Gipuzkoa, Spain. Building incineration capacity to burn more than 20% of the waste available is locking in waste prevention and recycling policies in the future. A recent study proves how this lock-in effect in place ssuch as Denmark, Sweden, Germany or Holland is threatening recycling and encouraging the shipment of waste that otherwise could be treated locally with less environmental cost. Reference: Jofra M., Ventosa I., 2013 "Incineration overcapacity and waste shipping in Europe: the end of the proximity principle?". This concern has also been reported in Greater Manchester, at the time of a thorough revision of the waste management system to foster material efficiency strategies. Reference: Uyarra, E. & Gee, S., 2012. Transforming urban waste into sustainable material and energy usage: the case of Greater Manchester (UK). Journal of Cleaner Production, pp.1–10. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0959652612006403 [Accessed January 30, 2013].	Rejected - this level of detail simply is not possible given space constraints in the ES; note also that MSW issues are addresses in the industry sector chapter of AR5, not in Chapter 7.
36711	7	5	22	5	24	The paragraph is not clear. What does "RE does not pose a practical constraint on their contribution" mean? Consider rewriting to make meaning explicit.	Accepted - text revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26946	7	5	22		24	Include 'with the exception of biomass/waste that poses a constraint to mitigation through materials efficiency strategies. This sentence is important including to make a reference to the lock-in posed by the biomass/waste incinerators, that will prevent material efficiency strategies for a long period of time, as incinerator ususally take u contracts for 30-40 years to compensate the heavy initial investments needed. This example should be included in this section for the widespread and increasingly important presence of this industry in developing countries where there is a risk to reproduce the problems of overcapacity faced in developed countries. In the case of incinerators, the generalised lock-in has created a situation of incineration overcapacity -more capacity to burn than waste is or will be available-, with at least 80% of MSW being recyclable. Reference: Altair, 2013, Characterisation of households residual fraction in Gipuzkoa, Spain. Building incineration capacity to burn more than 20% of the waste available is locking in waste prevention and recycling policies in the future. A recent study proves how this lock-in effect in place ssuch as Denmark, Sweden, Germany or Holland is threatening recycling and encouraging the shipment of waste that otherwise could be treated locally with less environmental cost. Reference: Jofra M., Ventosa I., 2013 "Incineration overcapacity and waste shipping in Europe: the end of the proximity principle?". This concern has also been reported in Greater Manchester, at the time of a thorough revision of the waste management system to foster material efficiency strategies. Reference: Uyarra, E. & Gee, S., 2012. Transforming urban waste into sustainable material and energy usage: the case of Greater Manchester (UK). Journal of Cleaner Production, pp.1–10. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0959652612006403 [Accessed January 30, 2013].	Rejected - this level of detail simply is not possible given space constraints in the ES; note also that MSW issues are addresses in the industry sector chapter of AR5, not in Chapter 7.
19638	7	5	24	5	?	Given the advances in electricity systems modelling since AR4 I suggest the following addition to the executive summary at around line 24.. "Since AR4 there have been considerable advances in the modelling of fully- or highly-renewable elctricity systems. It has been shown that by using an appropriate mix of renewable resources and generation technologies coupled with energy storage, that functional and reliable fully- or highly-renewable electricity systems, are possible." (high agreement; medium evidence)	Rejected - Given very severe space constraints, we have added a brief reference to high-penetration RE studies in the ES, but not as specific and targeted as the one suggested here.
23252	7	5	24			Would have thought there would be "high evidence" given the SRREN findings.	Taken into account - text revised, including confident rating.
25374	7	5	25	5	26	This sentence should be left in this report, as it is a correct description about effectiveness of nuclear power in GHG emission reduction.	Noted.
34158	7	5	25		37	Nuclear power has also to be seen as one option in an entire portfolio of options. The results of the EMF-27, the RECIPE project and several publications have shown that nuclear power is the option that increasses mitigation costs by the smallest amount, if it is considered unavailable. Also Figure 6.23 of this report. Since the entire Chapter 7 is dealing with energy systems it is hence also necessary to view technologies within the systems perspective. This is what the assessment of the nuclear option here misses. It is important to provide information to this to policy makers of national and intenrational affairs because nuclear power policies and cliamte policies are interrelated and the question is how sensitive this link is. The recent literature provides scenario based evidence that should be considered here.	Taken into account - the overall mitigation cost aspects of delimited technology portfolios are discussed in chapter 6 in detail. Section 7.11 shows the role of nuclear energy in the portfolio of mitigation options. Space constraints in the ES do not allow for a detailed discussion there.
20713	7	5	25	5	37	A reference to thorium as a potential resource (as being actively explored in several countries) is surely worth brief mention. See also page 6, lines 35-37.	Rejected - The severe space constraints of the ES do not allow to go into the details here. The usage of Thorium, however, is discussed in 7.4.3 and 7.5.4.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
23733	7	5	25	5	26	Should read: "Nuclear energy, as most renewable energy sources, is capable of providing carbon free…".	Rejected - the statement is on the performance of nuclear. It is impossible to take other options into account at all occasions where they might be as good.
36712	7	5	25	5	26	Nuclear energy can be considered "low carbon", but not "carbon free."	Taken into account - nuclear is carbon free at the plant site, but it is obviously not in a life cycle assessment perspective. This is clarified.
36713	7	5	25	5	26	"Nuclear energy is capable of providing carbon-free electricity at the plant site and close to that on a life-cycle basis." What does "at the plant site" mean?	Taken into account - there are no CO2-emissions from the plant itself, although there are some on a life cycle perspective. This now is clarified.
26037	7	5	27	5	27	"Although nuclear power has been used for five decades, unresolved issues remain for a future 27 worldwide expansion of nuclear energy. The related barriers include operational safety, proliferation 28 risks, waste management and the economics of power plants." RECOMMEND: "Public acceptance of nuclear power is affected by perceived concerns relating to safety, waste management and proliferation. " JUSTIFICATION: The expression "Unresolved issues remain for a future worldwide expansion of..." could be written for other generation technologies, but has not been. For example, in the following section on renewables there is no reference to the unresolved issues of intermittency. Nuclear energy, supplying 13% of global electricity and in existance for over 50 years is a more proven technology than many other low carbon options.	Accepted - text revised.
23734	7	5	27	5	37	Too much space dedicated to nuclear energy. Reduce text to one paragraph to be fair with other RE sources	Rejected - nuclear energy is a potential mitigation option. The space is justified especially compared to RE.
23600	7	5	27	5	27	Delete "Although nuclear power has been used for five decades," . Consistent with the text page 28, line 22 to 24, this information could be placed two lines before, at the beginning of line 25 which could read "Nuclear energy has been used for five decades and is capable of providing carbon free electricity …"	Accepted - text revised.
36714	7	5	27	5	42	It is not clear what is seen as controversial in these paragraphs. Suggest that the confidence/evidence status should be increased.	Accepted. The confidence level has been modified.
20846	7	5	28	5	29	Seeing "Figure SPM.12.", it is confirmed that the nuclear cost is not higher than other sources. We should delete "the economics of power plants" from the barriers of nuclear energy.	Accepted - text revised.
25375	7	5	28	5	29	In this part, economics of nuclear power is regarded as one of the barriers. It needs to be examined adequately, as it seems to be one-sided aspect.	Taken into account - "economics of power plants" is deleted.
31431	7	5	28	5	29	We propose to rephrase the sentence, and apply the term "hazard" insted of "barrier": "The related hazards include operational safety, proliferation risk and waste management, as well as economic barriers.	Taken into account. The text now speaks about "concerns" about operational safety, …
25617	7	5	28	5	29	See comment No.7.	Noted - comment No. 7 cannot be located without additional information, but all comments are answered where they appear.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36715	7	5	28	70	31	Here, and throughout the document, when the word proliferation is used, as it is repeatedly, it should state "weapons proliferation". The nature of the proliferation and the connection between nuclear power and nuclear weapons needs to be clear.	Rejected - in chapter 7, the word "proliferation" is used always in the context of nulcear energy, where it is clear what it means. "Weapons" proliferation is too narrow as the proliferation of material suitable for weapon production is to be addressed as well.
34159	7	5	29		32	The authors miss to emphasis here the probable need of a strong international system of nuclear weapon control that might get more necessary as climate change mitigation gives a boost to nuclear power industry. This is an urgent issue and it is relevant for policy makers in international affairs because nuclear weapon control and non-proliferation treaties are a matter of international policies.	Rejected - the severe space constraints do not allow going into such details in the ES.
31239	7	5	29	5	32	This sentence is unclear, but I think that the authors are trying to say that, "In the absence of recycling of nuclear wastes (via repocessing plants), the availabilty of nuclear fuels will serve as a long term constraint on the nuclear power supply"	Taken into account - comment is obsolete as the underlying text has been deleted.
30066	7	5	29			(… waste management and the)micro and macro (economics of …)	Taken into account - the comment is obsolete as the underlying text has been deleted.
30067	7	5	30	5	32	I do not agree!	Rejected - reviewer comments can only be handled if they are supported by arguments.
24400	7	5	33	5	37	I think the biggest impact of Fukushima is that it demonstrated the enormous impact on society that a single nuclear power plant accident can potentially have. For a time, the Japanese considered evacuating the entire city of Tokyo, one of the world's greatest cities, with a population of over 13 million people and the nation's capital. No other energy technology could have such a large potential impact.	Accepted - text revised.
36716	7	5	33	5	36	To "health, environmental and economic implications", suggest tha the authors add "safety-related."	Taken into account - comment is obsolete as the underlying text has been deleted.
30538	7	5	33	5	47	I think this is unnecessary and could be removed	Rejected - information given on page 5, line 33 - 42 is important for the assessment of nuclear energy and RE. The text between line 43 and 47 has been rewritten.
23593	7	5	35	5	37	This sentence may be understood as suggesting that Fukushima could in the long term appear as severe as Chernobyl. Is it really what is meant ?	Taken into account. Language changed.
34160	7	5	38			It is not clear what is integrated into what.	Accepted - text revised.
25703	7	5	4	5	5	This part should be kept in the final version report and also explain that there are many concerns about CCS such as safety confirmation, storage potential, high cost or public acceptance, as described in (Finkenrath, 2011, page7), (Rubin, 2007, page4447, Table3), (Lohwasser, 2012, Abstract), and (Zoback, 2012, Abstract). CCS cost depends on a number of conditions such as concentration of CO2 in the exhaust gases, capture technology, access to storage site, storage potential, and CO2 monitoring. These literatures are listed in the No12 line of this table.	Taken into account - the concerns now are expressed explicitly.
36706	7	5	4	5	5	CCS has been applied to commercial fossil-fired generation for testing purposes though these have been at small scales relative to the plant itself. Hence, add "at scale" after "applied", i.e., "CCS has not yet been applied at scale to a large..."	Accepted. Wording has been changed. This is a very insightful comment.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24629	7	5	41	5	42	The current wording could confuse readers regarding price per unit of energy and energy cost of delivering a service. When doubling the efficiency of use, a doubling of the energy price will not affect the total cost of energy required. It therefore may be misleading to state that energy costs will increase when talking about energy price per unit of energy. Suggest a clearer distinction between an increase in energy price per unit and overall energy costs.	Rejected - the statement speaks about "may" increase and is therefore correct. There is no space to go into the details in the ES.
30068	7	5	41			(… in higher) short term (energy …)	Rejected - the integration challenge is expected to result in additional costs.
30069	7	5	44			(…in) some regions of (Africa and Asia…)	Taken into account - comment is obsolete as the underlying text has been deleted.
30063	7	5	5			(generation facility) mostly due to high costs, unsolved risks and axceptance problems	Taken into account - the related problems are highlighted elsewhere in the ES.
30537	7	5	5	5	6	The actions mentioned are done for reasons other than climate change	Noted. It is not clear what change is being requested.
21100	7	5	6	5	10	Some studies show that we still face an important lack of knowledge in order to safely use geological storage. For example, the french INERIS (Institut National de l'Environnement Industriel et des Risques) has published a serie of reports on these questions. They also conclude that some leakage scenarios have a high probability of occurrence. See http://www.ineris.fr/centredoc/95145-11842b-stockage-co2-2.pdf and http://www.ineris.fr/centredoc/fiche-stockage-co2-def.pdf . The text in 7.5.5 should be more balanced in presenting the CCS, showing that there still indeed big uncertainties about storage safety.	Taken into account- There is no room in the Executive Summary to get into this level of detail. The current wording is sound and should remain the way it is. Concerns about CCS, however, now are mentioned explicitly.
30064	7	5	6	5	10	I do not agree!	Noted. It is not clear what change is being requested.
36708	7	5	6	5	10	Suggest that the authors restructure the paragraph to make it clear that "medium agreement, medium evidence" specifically applies to "potential consequences."	Accepted - text revised in order to avoid any misunderstanding.
36707	7	5	6	5	6	Suggest that this should be "...the integrity of injection wells".	Accepted. "injection" will be inserted into the sentence as there are both CO2 production wells and CO2 injector wells.
27050	7	5	18			Add "to a level similar to or lower than fossil fuel and nuclear technologies", after "wind energy,". Onshore wind is beating coal at a levelized cost basis in Australia, according to Bloomberg New Energy Finance (see for example http://www.newscientist.com/article/dn23159-wind-power-is-now-cheaper-than-coal-in-some-countries.html). Onshore wind is also beating natural gas and hydro in Brazil (see for example http://www.bloomberg.com/news/2011-08-18/wind-beats-natural-gas-hydro-in-brazil-power-supply-bidding.html).	Rejected - the LCOE of wind cannot legitimately simply be compared to the LCOE of a new gas or coal plant, as wind is non-dispatchable and variable. Moreover, while it may be true that there are certain countries where wind is economically competitive with current fossil prices, these are the large minority, or otherwise there would be no need for public support to encourage wind deployment. Absent peer-reviewed citations and evidence, this comment must be rejected.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
31628	7	5	17	5	18	(Also line 8 p 24) it is nowehere explained why increased turbine size improves levelised costs of onshore installations but on the prospects of offshore installation. True, offshore installations have only become viable as multi MW turbines have become available but this must be a function of the costs. Some clarification is needed.	Taken into account - comment is obsolete as the underlying text has been deleted.
31627	7	5	6	5	10	Long sentence that would benefit from restructuring and might be easier to assimilate if presented as a bulleted list.	Accepted - text revised. A bullet list, however, is not possible due to space constraints.
34334	7	50	1			Please consider adding Sovacool (2008): The costs of failure.	Accepted. Reference has been considered.
34792	7	50	13	50	15	Regarding fatalities I think that some of the figures allocated to hydropower are not correct. Only 1/4 of all large dams in the world have hydropower as one of the purpose.	Taken into account. Figures have been updated.
26620	7	50	13	50	15	Attributing these deaths to failures of hydropower technology is a leap. The primary purpose of the Banqiao/Shimantan dam was for flood control purposes. The failure of the dam and associated deaths can be attributed to a natural disaster - Typhoon Nina in 1975. The sentence, as is, is misleading in that the natural disaster is left unmentioned and it is implied that the dam simply failed under normal operating conditions. Furthermore, their is no source or indeed no information provided on the details of the remaining 4,000 death attributed to hydropower. If this can't be substantiated, it should be removed.	Taken into account. References (to SRREN) have been added. The fact that a Typhoon caused the dam breach is not substantial; dams need to withstand Typhoons. Please note that the deaths named here are only the immediate deaths not those from the famine that followed.
36872	7	50	13	50	18	Total fatalities of 30,000 requires a reference. Chernobyl 370 persons also requires a reference.	Accepted
40691	7	50	16	50	24	For the Chernobyl accident, effects on human health are reviewed in UNSCEAR 2008 Report (http://www.unscear.org/unscear/en/publications/2008_2.html; Appendix D) under an international cooperation, and this report should be referred instead of papers by individual researchers.	Taken into account. The text has been revised to differentiate between the findings of the peer-reviewed journals and that of assessments by international scientific committees.
26040	7	50	19	50	20	"with the total incidence estimated to 1000 cases so far and another 15000 cases until 2065, mostly non-fatal." RECOMMEND "with the 19 total incidence estimated to 1000 cases so far, almost all non-fatal." JUSTIFICATION: The future cases of Thyroid cancer to 2065 are presented as fact. There can be no such knowledge. Any future figure is only a projection and should be stated as such.	Taken into account. Text has also been changed to account for new research findings, principally those of WHO
25949	7	50	2	50	2	...(e.g., Giroux, 2008), cumulative effects of wrong design or O&M, and human errors…	Editorial

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26041	7	50	21	50	28	"Epidemiological evidence for other cancer effects does not exist, and risk estimates depend on the assumption of a linear no-threshold dose-response relationship, which is controversial (Tubiana et 22 al., 2009). 14,000 to 130,000 cancer cases may potentially result (Cardis et al., 2006), and potential fatalities have been estimated 9,000 to 33,000 (Hirschberg et al., 1998). The Fukushima-Daiichi accident resulted in much lower radiation exposure. 30 workers received radiation exposure above 100 mSv, and population exposure has been low (Boice, 2012). Following the linear, no-threshold assumption, 130 (15-1100) cancer-related mortalities and 180 (24-1800) cancer-related morbidities have been estimated (Ten Hoeve and M. Z. Jacobson, 2012)." RECOMMENDATION "Epidemiological evidence for other cancer effects does not exist, and risk estimates depend on the assumption of a linear no-threshold dose-response relationship. JUSTIFICATION UNSCEAR has recommended that that "the Scientific Committee does not recommend multiplying very low doses by large numbers of individuals to estimate numbers of radiation-induced health effects within a population exposed to incremental doses at levels equivalent to or lower than natural background levels." (UNSCEAR Fifty-Ninth Session 21–25 May 2012). The presentation of estimates by (Cardis et al., 2006), (Hirschberg et al., 1998) and (Ten Hoeve and M. Z. Jacobson, 2012) runs counter to this recommendation. All three studies quote very wide ranges for their estimates of cancer cases or mortalities. In particular those of Hoeve and Jacobson are so wide they have very little value or meaning. The inclusion of these disputed estimates is not justified given the low agreement and the lack of epidemiological evidence.	Rejected. It is the task of the IPCC to consider both sides in a scientific dispute. We note that UNSCEAR does not adopt the practice of low-dose impact estimation taken by some peer-reviewed publications, but neither does it explicitly reject that. There is a scientific debate about the validity of such an approach that has been acknowledged in the text by explicitly referring to a frequently-cited paper by Tubiana arguing rejecting the linear dose-response curve, but this is a position that is not accepted by all risk assessors, as the response to this paper shows.
25383	7	50	23	50	23	This sentence should be removed from this report. The range which shows the number of cancer cases is too large and seems not to be appropriately quoted from the reference material.	Rejected. The paper states: Models predict that by 2065 about 16,000 (95% UI 3,400–72,000) cases of thyroid cancer and 25,000 (95% UI 11,000–59,000) cases of other cancers may be expected due to radiation from the accident,
25622	7	50	23	50	24	The deviation of the cancer potential seems too wide.	see comment 25383
20851	7	50	25	50	28	Regarding the influence of Fukushima accident to human body, there are many disputes. It lacks the balance to write a peculiar estimation. This text should be deleted.	Rejected. The review comment could not point to any specific flaw in the draft.
23607	7	50	25	50	25	Add a foot note after "accident : "The origin of this acident was a large tsunami which caused some 20 000 deaths."	Editorial.
23307	7	50	25		28	Page 28, line 13 doesn't match with this text. Says is too soon to tell outcomes.	Editorial. Text on p. 28 changed.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
40692	7	50	25	50	28	For effects on human health resulting from the Fukushima-Daiichi accident, overall consensus is not reached yet, so it is misleading to discuss them with reference to a limited number of papers. International reviews on effects on human health are currently in preparation by experts in radiological protection, under the direction of WHO and/or UNSCEAR. (Internationally, the WHO released “Preliminary dose estimation from the nuclear accident after the 2011 Great East Japan Earthquake and Tsunami”(http://www.who.int/ionizing_radiation/pub_meet/fukushima_dose_assessment/en/) in May 2012, and “Health risk assessment from the nuclear accident after the 2011 Great East Japan earthquake and tsunami, based on a preliminary dose estimation”(http://www.who.int/ionizing_radiation/pub_meet/fukushima_risk_assessment_2013/en/). And UNSCEAR is currently undertaking an assessment of radiation dose, and its report is scheduled to be discussed by the Committee in May 2013, then the final outcome is to be issue to the UN General Assembly in October 2013.(http://www.unscear.org/unscear/en/fukushima.html)) Then it would be appropriate to leave such assessments to them. (And if such assessments are included in this report, the reports by the WHO should be referred.)	Taken into account. Please take note that we quote relevant peer-reviewed scientific papers, without endorsing them. We have now added a reference to the WHO report, which has been released since then, but that report does not come with very crisp findings.
26180	7	50	26	50	28	The auther quotes idea of radiation protection above 100 mSv here but it doesn't apply to general public. Caluclation become wrong in itself. (2007 Recommendations of the International Commission on Radiological Protection, ICRP publication 103)	Rejected. It seems that the reviewer has misunderstood the statement; it explicitly specified 30 workers and not the general public.
40693	7	50	36	50	36	This statement, under the condition that early international cooperation is not realized, suggests the necessity of the large-scale application of CDR technologies and concludes that achieving 450 ppm CO2eq without overshoot becomes physically infeasible if such delay in the cooperation lasts beyond 2030. But from a contrasting perspective, this can be interpreted as suggesting the realization of 450 ppm CO2eq target without overshoot under the early international cooperation, and even the possibility of not being dependent on BECCS technologies. For the emissions pathways without overshoot or without dependency on BECCS technologies, it seems practically possible to show concrete examples of scenarios and their premises on which the pathways rely on, such as specific portfolios of assumed technological factors and the time frames of their deployment (e.g., the scale of application of CDR technologies or the degree of uncertainty that accompanies etc.) or transitional cost curbs over time; so such examples should be given at first, and failures in achievements in the original statement should be rephrased as a deviation from the examples.	Rejected. The statement is misplaced and makes no sense in reference of the page and line numbers provided.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
40694	7	50	36	50	36	The Referred paper (Ten Hoeve and M. Z. Jacobson, 2012) should be removed. ICRP mentioned that, “Collective effective dose is an instrument for optimization, for comparing radiological technologies and protection procedures. Collective effective dose is not intended as a tool for epidemiological studies, and it is inappropriate to use it in risk projections. This is because the assumptions implicit in the calculation of collective effective dose (e.g., when applying the linear no-threshold (LNT) model) conceal large biological and statistical uncertainties. Specifically, the computation of cancer deaths based on collective effective doses involving trivial exposures to large populations is not reasonable and should be avoided. Such computations based on collective effective dose were never intended, are biologically and statistically very uncertain, presuppose a number of caveats that tend not to be repeated when estimates are quoted out of context, and are an incorrect use of this protection quantity (ICRP Publication 103)”. The methodology and derived figures based it in this paper does not deserve a scientific consideration. And the author of the paper is an expert in meteorology, not an expert in radiological protection (http://www.johntenhoeve.com/). The paper to be removed: Ten Hoeve J.E., and M. Z. Jacobson (2012). Worldwide health effects of the Fukushima Daiichi nuclear accident. Energy and Environmental Science 5, 8743?8757.(http://www.johntenhoeve.com/publications/TenHoeveEES2012.pdf)	Taken into account. The proper place to criticize the scientific literature is in scientific journals. Note that among the papers that cite this paper in question, there is only one article that criticizes the findings, and that is for them being too low because THJ do not take into account Cs137. We state that the LNT hypothesis is controversial, but still find the numbers derived in the papers as being of interest to the readers.
21151	7	50	38	50	45	This para is too optimistic with regards to the consequences of nuclear accidents and it seems to minimise the risk and consequences of water contamination	Rejected. We do not make statements that this has been achieved but merely note efforts to improve the safety of new nuclear power plants.
32837	7	50	4	50	5	Reference needed here.	This comment may be misplaced.
25384	7	50	42	50	45	This part should be left in this report, as it is a correct description about efforts to enhance the safety of nuclear power.	Taken into account
32838	7	50	5	50	8	What is the time basis and location covered by the ENSAD? Similarly, 33000 fatalities over what period and in what location?	Accepted text revised.
33055	7	50	7	50	8	The singling out of China here seems strange. Please justify the reason for its focus, and indicate how this number compares with the rest of the world.	Taken into account. Statement reformulated. China stands out as accounting for more than half of historic coal mining accident fatalities and for having substantially reduced fatality rates; in addition good statistics are available. Finding from the US are now also added.
36871	7	50	9	50	12	over what time frame?	Editorial

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26042	7	50	29	151	51	Figure 7.14 and accompanying text is not scientifically rigorous as it mixes historical data, 'expert judgement' and PSA. Comparisons between generation options are not valid because similar metrics are not being used. The estimates for latent fatalities for nuclear rely one study, and makes assumptions based on a linear no-threshold dose-response relationship UNSCEAR has recommended that that "the Scientific Committee does not recommend multiplying very low doses by large numbers of individuals to estimate numbers of radiation-induced health effects within a population exposed to incremental doses at levels equivalent to or lower than natural background levels." (UNSCEAR Fifty-Ninth Session 21–25 May 2012). The document should not include such speculative projections, lacking scientific agreement and empirical evidence. If such speculative figures were to used then similar speculative data on the potential fatalities through climate change impacts of fossil fuels should be added. With the exception of Chernobyl, the historic fatalities associated with nuclear energies and renewables excluding hydropower are far more limited than those shown by the speculative data in Figure 7.14, limited to those deaths associated with construction, operation and maintenance, and, in the case of Fukushima Daiichi, two fatalities resulting from drowning following the flooding of the site from the tsunami of 11 March 2011.	Taken into account. Figure removed.
26873	7	50	46	50	47	rephrase "exhibit distincly lower fatality rates" to "exhibit significantly lower…" this is a better reflection of the figures in figure 7,14. Moreover, the claim that fatalities due to RE are comparable to nuclear power does not seem appropriate in light of Fukushima-Daiichi.	Noted. Text has been changed.
33012	7	51				Please note that the regions presented in this figure don't conform to those agreed for use across the AR5. It may be useful to update them, if possible.	Taken into account. Figure removed.
20552	7	51	1	51	2	Could emphasise more strongly the point that renewables in many cases outperform conventional technologies in terms of their consequences, because most renewables are deployed in more decentralised manner.	Taken into account. Please note that there is not data available on total occupational impacts.
21152	7	51	11	51	16	This para in isolation from the next one can be wrongly quoted. Rephrase to avoid this happening.	Editorial
31672	7	51	12	51	13	This is largely true although significant radioactive contamination can occur in relation to mining if the target mineral is closely associated with a radioactive materials. There is at least one axample of this with regards to coal mining. For example in the Almaty region of Kazakhstan the United Nations Economic Commission for Europe (2000) reported that 15,000 t of radioactive coal material have been stockpiled from a brown-coal mine, with the levels in the coal fines being five times more concentrated than in the raw coal. The identified threat is from wind dispersion of the fines. Ref: United Nations Economic Commission for Europe (2000) Environmental performance review Kazakhstan. New York and Geneva, United Nations, 118 pp (2000)	Rejected. While interesting, this is too specific to be addressed here.
31673	7	51	13	51	13	This paragraph changes topic here. The second part of the paragraph should be moved to the start of the next pragraph.	Editorial.
23308	7	51	16			Better to reference a specific chapter of SRREN.	Editorial.
26780	7	51	22			More detail and attempts at quantification of the risks of groundwater contamination and other risks can be found in: "Support to the identification of potential risks for the environment and human health arising from hydrocarbon operations involving hydraulic fracturing in Europe", 2012, AEA http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf	Taken into account. Please note the reference provided is to grey literature and hence not addressed here.
23309	7	51	22			Methane leakage not mentioned for fracking.	Taken into account. Methane leakage is addressed in 7.5.1
36874	7	51	22	51	22	Unclear terminology: "Spills" do not occur during fracturing; they occur prior to or after. Replace "spills" with, e.g., "leakage", to more clearly denote unintended flows.	Accepted.
36873	7	51	3			It is difficult to estimate deaths and consequences of severe accidents for EGS. In fact, there are at present only several very small EGS in operation, with no deaths or severe accidents.	Taken into account. Figure has been removed.
23608	7	51	6	51	6	Explicit PSA	Taken into account. Figure removed.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26874	7	51	1	51	2	The sentence is clearly worded incorrectly as accidents at RE power plants will never have "catastrophic" impacts such as those at nuclear or conventional plants. A more correct wording would be "their decentralised nature further limits their capacity to have significant impacts".	Accepted.
21860	7	52	1			It seems very odd having a sub-section on public perception (social acceptance?) in a co-benefits, risks and spillovers section. There also seems to be almost nothing on spillovers in this section (7.9).	Rejected - This sub-section is really about "adverse" public perception, and therefore it does seem to fit within the (risks) section, but, admittedly, the title might not make that particularly clear. The first sentence, does, though, seem to clarify what the title does not.
23310	7	52	1			Footnote doesn't mention storm damage risk, undergrounding, etc.	Rejected - This section is on public perception not infrastructure risks
20731	7	52	16	52	27	Does thorium fall into the same risk category?	Rejected - Although Uranium (which is the more commonly used nuclear reactor fuel) may have higher risks than Thorium, public perceptions of those risks may be directionally similar and, more broadly, we do not have the space in this section to address this level of detail.
26621	7	52	38	53	6	For FAQ7.3, in the case of hydropower as a GHG mitigation technology, a co-benefit is its contribution to climate change adaptation.	Rejected - This is mentioned in Section 7.7 of the chapter. The box does not seek to be comprehensive, so we opt not to mention this specific possibility here.
21153	7	52	38	52	43	Reduced vulnerability to price volatility' not true with variable sources such as wind and solar	Rejected - RE sources often have no fuel costs and can be priced at fixed costs via long term contracts and therefore are not subject to the same volatility as was implied for non-RE (fossil) sources. Current text does not address this level of detail, but simply indicates that both mitigation and non-mitigation technologies can sometimes provide these co-benefits. Current text is accurate and concise in our view, without going into the details. The broader issues noted by the comment are addressed elsewhere in the chapter.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36875	7	52	38	53	6	This box usefully summarizes section 7.9. As such, it could replace some of the main body text - improving readability, removing redundancies, and tightening the Chapter.	Rejected - The FAQs are intended to be stand-alone pieces, with the underlying information supporting the FAQs in the text, with appropriate citations.
19074	7	52	5	52	7	"For bioenergy, for example, concerns focus on direct and indirect land use and related GHG emissions, deforestation, and possible competition with food supplies". The principal cause of deforestation is not using wood for bioenergy, but clearing land for subsistence agriculture and cash arable and pastoral crops. If deforestation is to be eventually reversed, then agricultural productivity has to increase and population increase has to be tempered. The latter point most people are reluctant to accept. Increasing agricultural productivity in the subsistence sector is difficult, but agro-forestry and 'tree cash crops' could greatly assist in this. therefore, promotion of bio-energy may be a key.	Noted - comment does not seem to suggest any necessary change to the existing text, which intends to simply identify public concerns about bioenergy and does not indicate that deforestation is a primary cause of bioenergy. Issues related to biomass are addressed more thoroughly in other chapters of AR5, so the more general point here is more appropriately targeted to other portions of AR5.
25950	7	52	7	52	7	...and –in the case of biofuels- possible competition with food supplies…	Rejected - comment seems to suggest that competition with food might be limited to biofuels, and not the broader category of bioenergy. However, if agricultural land is used for feedstock for any form of bioenergy (whether fuels or electricity) the same concerns about competition might exist. As such, suggested revision is not made.
35394	7	52				Public perception of incinerators and waste disposal in general is increasingly negative due to the poor technological performance and notorious accidents that these have had in recent years, apart from other concerns regarding impacts to economies, environment and public health. A remarkable example is Detroit, where the incinerator industry has been hold responsible for the local economy crisis. A massive march in 2010 culminated with the temporary closure of the plant. Conant, J., 2010. “Detroit Shall Burn No More!” Incinerator Fight Heats Up. Race, Poverty and Environment. Other places where the opposition to incinerators has been studied has been Ireland, Davies, A.R., 2005. Incineration politics and the geographies of waste governance: a burning issue for Ireland? Environment and Planning C: Government and Policy, 23(3), pp.375–397. Available at: http://www.envplan.com/abstract.cgi?id=c0413j [Accessed March 27, 2012].	Noted - Issues of MSW are not addressed in ch 7, but are covered elsewhere in AR5. As such, this comment is better targeted to a different chapter.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
35447	7	52				Public perception of incinerators and waste dsposal in general is incresingly negative due to the poor technological performance and notorious accidents that these have had in recent years, apart from other concerns regarding impacts to economies, environment and public health. A remarkable example is Detroit, where the incinerator industry has been hold responsible for the local economy crisis. A massive march in 2010 culminated with the temporary closure of the plant. Conant, J., 2010. “Detroit Shall Burn No More!” Incinerator Fight Heats Up. Race, Poverty and Environment. Other places where the opposition to incinerators has been studied has been Ireland, Davies, A.R., 2005. Incineration politics and the geographies of waste governance: a burning issue for Ireland? Environment and Planning C: Government and Policy, 23(3), pp.375–397. Available at: http://www.envplan.com/abstract.cgi?id=c0413j [Accessed March 27, 2012].	Noted - Issues of MSW are not addressed in ch 7, but are covered elsewhere in AR5. As such, this comment is better targeted to a different chapter.
26955	7	52				Public perception of incinerators and waste dsposal in general is incresingly negative due to the poor technological performance and notorious accidents that these have had in recent years, apart from other concerns regarding impacts to economies, environment and public health. A remarkable example is Detroit, where the incinerator industry has been hold responsible for the local economy crisis. A massive march in 2010 culminated with the temporary closure of the plant. Conant, J., 2010. “Detroit Shall Burn No More!” Incinerator Fight Heats Up. Race, Poverty and Environment. Other places where the opposition to incinerators has been studied has been Ireland, Davies, A.R., 2005. Incineration politics and the geographies of waste governance: a burning issue for Ireland? Environment and Planning C: Government and Policy, 23(3), pp.375–397. Available at: http://www.envplan.com/abstract.cgi?id=c0413j [Accessed March 27, 2012].	Noted - Issues of MSW are not addressed in ch 7, but are covered elsewhere in AR5. As such, this comment is better targeted to a different chapter.
21861	7	53	16	53	20	Critial point about portfolio options, though (as noted later in the section), this is critically dependent on assumed levels of energy demand.	Take into account - the reference to ambitious climate protection goals has been deleted. As it stands, the text now is correct.
27785	7	53	2	53	4	When thinking of the negative impacts of nuclear energy, the problem of proliferation is not the first that comes to mind. The waste problem or the dangers of a nuclear accident seem much more relevant.	Taken into account - comment is obsolete. Underlying text has been deleted due to space constraints.
19075	7	53	21	53	21	7.10.2 Financial and investment barriers and opportunities. The investment in bioenergy production is relatively modest and much of the cash will go to rural people. However, the decision makers in government, (backed by the general tenor of this chapter) have been indoctrinated that 'traditional biomass' is bad. Promoting wind, water and solar energy will not financially benefit rural people and unless these forms of energy are subsidised, their use will be low. See the Owen article mentioned above	Noted- in short-term, there is substantial difficulty to deploy low carbon energy, but access to low-carbon energy is an important issue to be solved in the long run. Alleviating poverty issues are discussed in Chapter 3.
21154	7	53	23	53	23	is needed' - to do what?	Taken into account -sentence eliminated, so comment no longer relevant: "A cumulative investment of 37 trillion is needed to introduce technologies for the New Policies Scenario of IEA."
21862	7	53	24	53	26	Clarify whether investment data are total or incremental (relative to some baseline), and if incremental, what scenario are they incremental to? Later on (lines 36-40), additional investments are reported but relative to what?	Taken into account - Investment data are total. The additional investments are relative to the Reference. Sentence is eliminated, so comment no longer relevant.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21155	7	53	27	53	30	This para provides too much detail on calculations that are highly uncertain as function of economic growth which has been declining	Taken into account -Sentence eliminated, so comment no longer relevant.
23312	7	53	32			Change "It" to "The total"	Accepted
20732	7	53	36	53	40	How well do these estimates encompass the wide variation in performance of - for example - wind and solar PV schemes in different parts of the World?	Noted - The models referred here have multiple-regions structures. They also consider potentials of renewables based on geographical information.
21863	7	53	44	53	45	Important point about the relative capital intensivity of RE and nuclear as mitigation options shoud be drawn out more clearly.	Noted - Because of space limitation, this section cannot be comprehensive.
36876	7	53	7	56	39	Issues of liability and permanence of storage are considered important in the context of long-term carbon sequestration. Suggest that the authors include this in their discussion.	Taken into account - storage liability now is discussed in 7.12.
26912	7	53				There is little to no actual discussion of institutional barriers at the government/policy level, despite the title of this section. This is a crucial discussion in the IPCC report, and is largely missing at this time.	Take into account - text revised.
33056	7	53				This section fails to focus on the mitigation options presented in 7.5 and answering the question "are barriers stronger for some options over others?" E.g. are there more barriers to CCS? To RE?	Rejected - the existing literature does now allow for the requested decision. There are multiple barriers and it is impossible to resolve the respective decision problem in a general way.
19774	7	53	7			This is an interesting section but its material is not strongly relevant to Chapter 7. Perhaps other Chapters could host its sections (i.e. investment and finance etc)	Rejected - barriers and opportunities with regards the energy sector are important areas of consideration.
24651	7	53	10	53	11	Usefulness - it is unclear why strategies that target a -2degrees scenario are "ambitious". Suggest that -2degrees targets should be presented as the norm rather than the exception	Taken into account - comment is obsolete. Underlying text has been deleted due to space constraints.
23694	7	53	9	53	20	Is possible to delete	Taken into account - the first part has been deleted. The second provides some pointers and is necessary to stay.
24652	7	53				This section presumes familiarity with the New Policies Scenario of IEA. The different scenarios are difficult to understand without having read the IEA Report. Suggest inserting a short summary/background to the IEA report at the start of the section	Noted - sentence eliminated, so comment no longer relevant
23311	7	53	21			Sectiondoesn't distnguish beteen heat and power	Rejected - We do not have the space for comprehensiveness here. Financing is the main concern.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
34335	7	53	21			I suggest cutting out the first three and the fifth paragraph as they do not convey information about financil and investment barriers but about investment needs (could be useful to include in other parts of the chapter). The sixth paragraph rather belongs to the policy section and should be cut here - leaving the section with paragraphs 4, 7 and 8. An additional paragraph on investment barriers in ICs could be written (complementing the interestings paragraph on LDCs) and one on urban issues (complenting the one on rural issues) and more references should be added to substantiate the findings. One important barrier, for instance, is the investment rating practice that does not allow large funds from insurance companies to enter individual RE projects. A paragraph on this could surely be added by a CA from the financial industry. Other barriers relate to the unclear reliability and lifetime of new technologies.	Accepted in Part, Rejected in Part - The texts are revised based on the comments. However some paragraphs are retained because these are required to understand the contents. (IEA, 2012h) is added as a reference, because Table 4.9 of the report is a good summary of the investment barriers. Financial barriers are also found in BNEF and GEA referred in this section.
26810	7	54	12			Consider inclusion of the following- In developing countries particularly the relevant knowledge and capacity among various actors involved in the RE finance arena are often limited, resulting in increased risks and elevated costs. "IRENA (2012), Financial Mechanisms and Investment Frameworks for Renewables in Developing Countries (pg. 19), http://www.irena.org/DocumentDownloads/Publications/IRENA%20report%20-%20Financial%20Mechanisms%20for%20Developing%20Countries.pdf"	Taken into account - Because of space limitation, the sentence is not inserted, but the reference is added.
26803	7	54	12	54	15	This issue is one of the main findings of the International Renewable Energy (IRENA) Capacity Building Strategic Framework result of consultation with Member countries and Capacity building experts. http://www.irena.org/DocumentDownloads/Publications/Capacity_Building_Strategy.pdf	Noted - Because of space limitation, additional sentence and reference are not included. "IRENA (2012), Financial Mechanisms and ..." is referred.
30113	7	54	16	54	22	Does this paragraph refer mainly to rural areas in developing countries? If so, this should be stated.	Rejected - Mainly referring to developing countries, but not necessarily distinguish between developed and developing countries. Even in developed countries, some people may not pay for the initial investment.
23313	7	54	18			Should "low carbon energy" be "low carbon electricity"?	Rejected -not only electricity, but also direct use of energy (e.g. solar water heater) is considered.
35395	7	54	19		22	There is also need to microfinance at the city level for decentralised waste projects, which offer a great contribution to GHG emissions abatement, resource efficiency and sustainable development. Remarkable examples can be found in Pune, India, where a door-to-door collection service operated by a cooperative of almost 2,000 grassroots recyclers has been integrated into the city's waste management system and diverts enough waste to avoid 640,000 tons of greenhouse gas emissions annually. In Bueno Aires, Argentina, by organizing into cooperatives and taking collective political action, grassroots recyclers called cartoneros have gotten the city to adopt separation of waste at source, an essential step toward its goal of 75 percent of landfill diversion by 2017. Reference: GAIA, 2012. On the road to Zero Waste Successes and LessonS from around the World. In Indonesia, community-based solid waste management, named as 3R programs and garbage banks, supported by the national agencies and all stakeholders as one of the mainstream programs.	Noted - space constraints do not allow us to provide good practice of waste management. Waste is treated in the industry chapter.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
35448	7	54	19		22	There is also need to microfinance at the city level for descentralised waste projects, which offer a great contribution to GHG emissions abatement, resource efficiency and sustainable development. Remarkable examples can be found in Pune, India, where a door-to-door collection service operated by a cooperative of almost 2,000 grassroots recyclers has been integrated into the city's waste management system and diverts enough waste to avoid 640,000 tons of greenhouse gas emissions annually. in Bueno Aires, Argentina, by organizing into coop- eratives and taking collective political action, grassroots recyclers called cartoneros have gotten the city to adopt separation of waste at source, an essential step toward its goal of 75 percent of landfill diversion by 2017. Reference: GAIA, 2012. On the road to Zero Waste Successes and LessonS from around the World.	Rejected - space constraints do not allow us to provide good practice of waste management. Waste is treated in the industry chapter.
20498	7	54	19			change first to last	Taken into account - sentence is changed, so the comment is no longer relevant.
26811	7	54	19	54	22	Addition of reference to statement- Micro finance mechanisms (grants, concessional loans) adapted to the pattern of rural activities (for instance, instalments correlated with income from agriculture) are necessary to lift rural populations out of the poverty energy trap and increase the deployment of low carbon technologies. "IRENA (2012), Renewable Energy Jobs & Access (pg. 23), http://www.irena.org/DocumentDownloads/Publications/Renewable_Energy_Jobs_and_Access.pdf"	Accepted - Reference is inserted.
26956	7	54	19		22	There is also need to microfinance at the city level for descentralised waste projects, which offer a great contribution to GHG emissions abatement, resource efficiency and sustainable development. Remarkable examples can be found in Pune, India, where a door-to-door collection service operated by a cooperative of almost 2,000 grassroots recyclers has been integrated into the city's waste management system and diverts enough waste to avoid 640,000 tons of greenhouse gas emissions annually. in Bueno Aires, Argentina, by organizing into coop- eratives and taking collective political action, grassroots recyclers called cartoneros have gotten the city to adopt separation of waste at source, an essential step toward its goal of 75 percent of landfill diversion by 2017. Reference: GAIA, 2012. On the road to Zero Waste Successes and LessonS from around the World.	Rejected - space constraints do not allow us to provide good practice of waste management.
25951	7	54	20	54	20	...(for instance, energy supply design for specific uses and needs, so as…	Noted - because of space limitation, one example is presented. The sentence:"energy supply design for specific uses and needs" is general.
20499	7	54	22			Here a reference to the ADB programme for rural electrication should be made.	Noted - References are added. However as no particular reference is suggested for ADB and space is limited, ADB reference is not inserted.
21865	7	54	24	54	34	This section is very weak, and perpetuates an outmoded deterministic view of people, information and support for RE. There is a large body of literature which treats this issue with some sophistication (including in the SSREN), and this section on "cultural / institutional" barriers does not do it justice. Recommend it is just deleted or integrated better with public perceptions / social acceptance.	Rejected It is important to have this paragraph lines 24-34). Furthermore more than 70 % of the section is not only on renewable and is focused on DC. However in the first paragraph (lines 30 to 34) has been tightened to do justice to the cultural/institutional issues in connection with mitigation options

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26812	7	54	29			Consider for inclusion- In this context, Nationally Appropriate Mitigation Actions (NAMAs) devised by the public sector to mobilise private participation in low-carbon development can play an important role. Among policy-based NAMAs, they support a wide-ranging support vehicle which includes awareness raising campaigns, capacity building initiatives etc. "IRENA (2012), IRENA Handbook on Renewable Energy Nationally Appropriate Mitigation Actions (NAMAs) for Policy Makers and Project Developers (Pg. 8), http://www.irena.org/DocumentDownloads/Publications/Handbook_RE_NAMAs.pdf"	Rejected. This is best captured in the chapter on national policies (ch. 14).
25725	7	54	3	54	6	This part should include "voluntary agreement" of an effective method to improve energy efficiency and reduce GHG emissions, as described in the section 15.5.7.4. There are successful examples of "voluntary target scheme" in the world. Each industry in Japan has voluntary target and the voluntary target scheme has played a big role, as described in (Yamaguchi, 2012, page35 and 154), (Manuel, 2010, page 6 and 13), and (Yamaguchi, 2010, abstract). In addition, there is also a successful example of "voluntary target scheme" in Netherlands, as shown in (Martijin, 2002, page162). These literatures are listed in the No22 line of this table.	Noted - "Voluntary agreement" is discussed in Section 7.12. It is also discussed in Section 15.5.7.4.
25726	7	54	30	54	34	This part should explain that wind power and photovoltaic are not suitable for alternating fossil fuel firing power plants in terms of supply stability and electricity quantity. Variable RE resources cause the need for system balancing, as described in the section 7.6.1 (page 32, line 3). The higher planning reserve margin will result in more costly structure as a whole power system. This is because it is necessary to install additional equipments for power grid stabilization if variable power sources such as wind power or photovoltaic were installed into power grid, as described in (DeCarolis, 2006, page 395 and 403). This literature is listed in the No15 line of this table.	Rejected. The comment is out of context. This section is not about technical issues which are explained in other paragraphs.
21156	7	54	31	54	34	Opposition may also come from individual interests of not having a wind farm next door dominating the social collective interest of reducing CO2 emissions	Accepted This is now reflected. It has been highlighted in other comments.
19076	7	54	40	54	41	"Furthermore legal barriers are often hindering the penetration of modern energy services and distorting the economics of energy systems". There are several legal barriers distorting the availability and price of bioenergy. Examples are: bans on charcoal production (but not sale), ban on night-time transport of woodfuel (but not fossil fuels), Ban on cutting certain tree species, even if the person wanting to cut the trees owns them. Proof that the area is sustainably managed as a way to prevent legitimate harvest. See Owen article.	Accepted. Two lines and references have been added
31674	7	54	41	54	42	Although this link is intuitive, evidence is needed to support it.	Rejected. No space to develop further.We believe it is sufficiently explicit.
31675	7	54	45	54	45	Vandalism (an emotive term which carries with it implications of destruction which brings no practical benefit to the destroyer) is not the correct term for the creation of illegal connections and the physical damage that may be associated with it. Criminal damage more accurately describes the collateral damage caused during creation of illegal connections.	Accepted. Word vandalism is deleted. This will not change the content of the sentence.
31676	7	54	46	54	47	As the nature of the inefficiency is not described (population reached, systems safety and security of supply, economic viability etc?) the context for discussing alternative approaches is missing.	Rejected This is beyond the mandate of this section
33789	7	54	48			… and implementation of energy …	Accepted. Editing repeated twice.
36877	7	54	48	54	48	remove "and implemention"	Accepted. Editing repeated twice
20497	7	54	6			change could to are	Accepted -change from could to is.
21864	7	54	6	54	7	See previous point about the capital intensivity of mitigation options which makes this point about policy uncertainty all the more salient.	Noted -- References are added.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26809	7	54	6	54	7	Consider inclusion of the following- In addition, lack of policy certainty translates into greater market risk for financiers, which means higher borrowing costs, shorter loan tenors, and higher equity requirements for RE finance. "IRENA (2012), Financial Mechanisms and Investment Frameworks for Renewables in Developing Countries (pg. 56), http://www.irena.org/DocumentDownloads/Publications/IRENA%20report%20-%20Financial%20Mechanisms%20for%20Developing%20Countries.pdf"	Taken into account - Because of space limitation,the requested texts are not added, however the reference is added.
21910	7	54	8	54	15	CDM has been one of the main tools for moving funds to developing countries for low carbon projects. By the end of 2012 this has come to an end.	Noted
30545	7	54	8	54	8	The comment on LDCs is indeed true, but the real climate problem is in the major industrialising and industrialised nations is it not? Therefore designing systems around LDCs is not really addressing the climate issue	Noted - It is true the investments in developed countries are important. However it is also important to consider the investments in LDCs and this is really a challenge.
33057	7	54				This section is exclusively focused on renewable energy and fails to mention the other mitigation options in 7.5. A more balanced coverage of these options would be useful.	Rejected. It is not only focused on RE. The second paragraph (70 % of the section) is valid for both and is more focused on developing countries. Nevertheless, non RE options now are considered.
20733	7	54	30	54	34	I can equally inform you that living in a rural area where mean wind speeds are low and the installation of large wind turbine developments is high, there is no misunderstanding of the need for electricity o how it is made, but deep scepticism that poorly performing, consumer-subsidised wind energy developments are a sub-optimal route to achieving what is required. The fact that such subsidised developments cause house prices to fall and in some cases adverse health effects, as well as a severe visual intrusion, does not help. The SOD here is a grossly partial, and distorted, view.	Accepted. There is more discussion on this issue in section 7.9.4
23695	7	54	30	54	34	Is possible to delete:in the following line is clearly described.	Taken into account. The comment is not explicit enough.
31677	7	55	1	55	1	large' should be 'largest'	Noted.
21868	7	55	10	55	13	Do these IEA scenarios assume no premature retirement or partial load operation?	Rejected - comment seems to be misplaced.
21911	7	55	14	55	19	Given that producing a skilled workforce requires long-term planning there has to be an agenda for academic and vocational curriculum that will produce the right skills	Accepted - text added to that effect.
26805	7	55	14	55	19	Idem commnet n 10	Noted - the section has been edited to focus on issues related to demand for human capital capacity development, rather than on job creation or offsetting potentials of renewable energy vs other energy technologies.
23314	7	55	19			Suggest delete references from 1998 and 2002 - not needed in "what's new since AR4"approach.	Accepted - reference revised.
21211	7	55	20			Change to "installments"	Rejected - comment is not clear about what should be changed.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
34398	7	55	20	55	28	Please consider moving this to the section on socio-economic effects as other sector chapters have done.	Noted - the section has been edited to focus on issues related to demand for human capital capacity development, rather than on job creation or offsetting potentials of renewable energy vs other energy technologies.
25172	7	55	20	55	28	Economic growth and job gains increase energy demand. Authors should explain how economic growth is sustainable or de-linked from conventional fuel consumption in order for this section to be coherent.	Noted - the section has been edited to focus on issues related to demand for human capital capacity development, rather than on job creation or offsetting potentials of renewable energy vs other energy technologies.
25385	7	55	21	55	25	Delete “Although” and separate the sentence into two. This part seems to support only positive employment effect of RE. The negative effects should be described in parallel with the positive effects.	Noted - the section has been edited to focus on issues related to demand for human capital capacity development, rather than on job creation or offsetting potentials of renewable energy vs other energy technologies.
24407	7	55	21	55	25	"Although there are some reports indicating that large scale renewable energy deployment could have offsetting effects on the conventional energy sector and the overall economy, resulting in net job losses (Hillebrand et al., 2006; Frondel et al., 2010), several studies report net positive employment effects (Lehra et al., 2008; del Rio and Burguillo, 2009)." A disadvantage of renewable energy compared to fossil fuels is that it has much lower energy density. The flip side of this is that deploying the area needed to capture sufficient energy requires more labor. I'm concerned here that the authors are trying to just give two sides of a story instead of deciding on the right answer. (This is similar to journalists giving "both sides" of climate science.) I recommend you decide which of these studies are the most unbiased and accurate and report those results.	Noted - the section has been edited to focus on issues related to demand for human capital capacity development, rather than on job creation or offsetting potentials of renewable energy vs other energy technologies.
27071	7	55	27			Add total power sector investments (in $) to the berginning of the paragraph. It can be derived from the reported figures, but it would improve the reading experience tremendously to add that one total figure which.	Noted.
26806	7	55	27	55	28	The sentence "shortage of teachers… have been reported" is extremely important. I suggest to move it at the end of the previous paragraph, seem it suits better.	Accepted - text edited.
20501	7	55	30		32	Reference Wei: Why is only CCS and nuclear mentioned, which compared to the job creation by RPS are much lower? Either treat all options or delete the sentence.	Noted - the section has been edited to focus on issues related to demand for human capital capacity development, rather than on job creation or offsetting potentials of renewable energy vs other energy technologies.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25727	7	55	30	55	32	This part should be kept in the final version report because it is important to explain the employment effect of nuclear power. There are many job opportunities relating to nuclear power in the world and those will increase potentially in future, as described in (M. Wei, 2010, page922, Table2). <Reference> [1] M. Wei et al. (2010). Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US? Energy Policy 38.	Noted - taken into account in the edited version.
23315	7	55	30			Replace ". CCS and nuclear power also" with "that"	Accepted - sentence edited.
26807	7	55	37	55	40	Idem comment n 15	Noted - the section has been edited to focus on issues related to demand for human capital capacity development, rather than on job creation or offsetting potentials of renewable energy vs other energy technologies.
31678	7	55	4	55	4	Again 'vandalism' is mentioned. This does not appear the correct term if this relates to collateral damage due to interference with the electricity system for gain.	Accepted. Word vandalism is deleted. This will not change the content of the sentence.
31439	7	55	41	56	39	The main findings in Chapter 7.10.5 on lock-in should be reflected in the summary of this chapter as well as in the SPM.	Accepted - A key general finding from 7.10.5 is now being placed in the Chapter 7 Executve summary: "Energy systems are highly path dependent: policy decisions and investments made in the near term will have a large impact on the attainability and costs of long term mitigation pathways [7.10, 7.12, high agreement; medium evidence]" - plus the specific finding "if current trends continue, by 2015 at least 90% of the available “carbon budget” will be allocated to existing energy and industrial infrastructure, and in a small number of subsequent years there will be extremely little room for manoeuvre at all."
20502	7	55	42		47	In this paragrph the prediction of how much additional power is needed until 2035 is missing (IEA 2012). This figure determines the market and not the figures from 2000 to 2010. As new RES have only picked up in the last few years, an actual comparison over the last five year would depict a more precise picture of the investment dynamics. For the short term until 2017, the IEA Medium Term Renewable Market outlook shows the dynamics well. In addition a statistic what kind of power plants were retired should be included as well.	Taken into account - We have retained the a 2000-2010 investment data as these are long-lived investments, but have noted the accelerating share in RES investment since 2005.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21866	7	55	42	55	47	Again, this section is very very electricity biased.	Taken into account - A much broader discussion of inertia and lock-in is given in section 5.6.3 - this is now correctly cross referenced. The discussion of non electricity sectors is discussed in the opening paragraph of this section and with specific examples now added to the last paragraph of this section.
19077	7	55	7	55	7	7.10.4 Human capital capacity building. As mentioned previously, some training for rural people for bioenergy production, transportation and use required coupled with appropriate tools, removal of barriers and provision of modest loans.	Noted - the need for human capital capacity building in rural areas is already covered, other issues are treated in chapters dealing with socio-economic issues.
21867	7	55	8	55	9	Including the need to consider "physical, financial, human capital and institutional" barriers is close to meaningless! Either specify what these barriers are (with examples), or delete.	Rejected - comment seems to be misplaced.
26804	7	55	8	55	13	Very good. There is too much focus in building institutional capacities, but so little done in addressing the lack of qualified human skills in the market. Please quote previos publication: International Renewable Energy (IRENA) Capacity Building Strategic Framework result of consultation with Member countries and Capacity building experts. http://www.irena.org/DocumentDownloads/Publications/Capacity_Building_Strategy.pdf Besides IRENA has created www.irelp.org to address this issue.	Accepted. IRENA reference included.
26827	7	55	25	55	25	It is "Lehr et al." and not "Lehra et al."	The text has been removed due to reasons given for line 20.
23696	7	55	41	56	39	Is possible to delete	Rejected - This subsection is required under the agreed chapter structure and also as a key barrier in the energy supply system.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
27072	7	56				The biggest barrier to overcome should be added: Removal of fossil fuel subsidies. IEA has lots of data on this.	Accepted - The discussion of subsidy removal is strengthened in section 7.12 - including the reference IMF (2013), "Energy subsidy reform: lessons and implications". This discussion includes the key points: Subsidies encourage "excessive energy consumption, artificially promoting capital-intensive industries, reducing incentives for investment in renewable energy, and accelerating the depletion of natural resources". "Even future generations are affected through the damaging effects of increased energy consumption on global warming". "The advanced economies account for about 40 percent of the global post-tax total, while oil exporters account for about one-third. Removing these subsidies could lead to a 13 percent decline in CO2 emissions and generate positive spillover effects by reducing global energy demand".
31679	7	56		56		This could be edited to provide focus on the answer to the question and remove peripheral information - thus saving a few lines of space. Perhaps a short table of energy source type vs barriers would be clearer with a rough estimation of the scale of the barrier (Hi, Med, or Low) in a global context, would be a good way to communicate this answer.	Rejected - The current focus of the section is consistent with a broader discussion of path dependence in section 5.6.3.
33058	7	56				The text in this box is only loosely aligned with what appears in Section 7.10. It would be useful to mirror the section exactly for consistency.	Accepted - We agree with this criticism of FAQ 7.4. The key messages from each of the 5 subsections in 7.10 are now pulled out into FAQ 7.4.
21912	7	56	10	56	13	Path dependence and lock in are some of the main barriers for change.	Accepted - Key points from 7.10 subsections are now in FAQ 7.4.(now called FAQ 7.3).
36879	7	56	13	56	13	"No room for maneuvre" seems far too extreme -- there is room for maneuvre; it just requires some premature capital retirement.	Taken into account - This statement is already prefaced by "if current trends continue", but the text has been edited to soften the language: "and in a small number of subsequent years there will be extremely little room for manoeuvre at all".

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19078	7	56	21	56	22	FAQ 7.4 What barriers need to be overcome in the energy supply sector to enable a transformation to low GHG emissions? The points for expanding 'high carbon' bioenergy have been made above. However, the chapter keeps repeating 'low-carbon' energy when it means low fossil fuel energy!	Taken into account The FAQ 7.4 (now called FAQ 7.3) box has been edited to better pull out key points on barriers. Note however, that this chapter should refer to low carbon energy, as fossil fuel use with CCS is a key CO2 abatement option.
26181	7	56	23	56	25	Please change mean temperature to 2100 tempature acoording to table 6.1.	Rejected - This refers to temperature change according to agreed global targets via the Cancum Agreement as opposed to temperature changes from alternate emission pathways as compared in table 6.1.
25728	7	56	23	56	25	This part should explain unlimited evaluation results because it is prejudicial and misleading to put an emphasis on limited scenarios of 2℃. IPCC should be policy-neutral and should have responsibility to indicate unlimited evaluation results, as described in Table 6.1. The 2℃ target is extremely difficult to attain, as described in (Höhne, 2011, conclusion) and (Rogelj, 2011, abstract). These literatures are listed in the No4 line of this table.	Rejected - These lines take seriously international community agreements, as Cancun, and the existence of a technical potential to achieve them. Only in relation to that it makes sense to establish a list of barriers.
23316	7	56	24			Replace "achieve" with "constrain" and "of" with "to".	Accepted
20503	7	56	27			market energy prices: It would be worthwile mentioning that these "market" prices are distorted by energy subsidies in a lot of countries (see IEA subsidy report).	Accepted. The FAQ 7.4 (now called FAQ 7.3) box has been edited to better pull out key points on barriers. This includes subsidy removal which is also discussed in sections 7.12
36878	7	56	3	56	3	Remove "effective." Consider also citing Davis, Caldeira, and Matthews (Future CO2 emissions and climate change from existing energy infrastructure, Science, Vol. 329, 2010).	Rejected - "effective" is included to reflect the multiple comments that lock-in from existing investments is not absolute (such as in the extinction of a species), but is very difficult/expensive to address. Davis, Caldeira, and Matthews (2010) is already cited in this sub-section.
20504	7	56	31		33	What about the problem of proliferation?	Taken into Account. The FAQ 7.4 box has been edited to better pull out key points on barriers. Proliferation is discussed throughout the chapter and is included in the Executive Summary's key messages.
19079	7	56	34	56	35	"For least developed countries, deep penetration of low carbon technologies will require financial support coupled to sustainable technology transfer". Again the promotion of 'low carbon' technology seems to be your answer to the maiden's prayer. While I am not opposed to 'low carbon' technologies, the chapter impies that it is the only solution.	Taken into account - The FAQ 7.4 (now called FAQ 7.3) box has been edited to better pull out key points on barriers.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25623	7	56	37	56	39	What kind of policy would be centered depends on each country's situation.(See Chapter 15 P51 FAQ 15.2) Replace this sentence by "Approporiate policy mix depending on national and local circumastances and institutional capacity should be designed."	Accepted - The FAQ 7.4 (now called FAQ 7.3) box has been edited to better pull out key points on barriers and their national circumstances.
25729	7	56	37	56	39	This part should include "voluntary agreement" of an effective method to improve energy efficiency and reduce GHG emissions, as described in the section 15.5.7.4. There are successful examples of "voluntary target scheme" in the world. Each industry in Japan has voluntary target and the voluntary target scheme has played a big role, as described in (Yamaguchi, 2012, page35 and 154), (Manuel, 2010, page 6 and 13), and (Yamaguchi, 2010, abstract). In addition, there is also a successful example of "voluntary target scheme" in Netherlands, as shown in (Martijin, 2002, page162). These literatures are listed in the No22 line of this table.	Accepted - The FAQ 7.4 (now called FAQ 7.3) box has been edited to better pull out key points on barriers. The issues of voluntary agreement policies is now discussed in more detail in chapter 7.12.
21869	7	56	42	57	25	This is very repititious. Delete. Novelty in this section begins on page 57, line 25-	Accepted. We consolidated the chapter.
36880	7	56	43	57	30	Footnote 17 should quantify (1) the energy sector share of total non-CO2 emissions, as well as (2) the non-CO2 share of total energy sector emissions - on a CO2-equivalent basis reflective of these gases' generally high GWPs. Suggest that authors also add a paragraph to text on item (2), more extensively characterizing energy sector non-CO2 emissions and highlighting associated abatement potential.	Accepted. We now tried to be more specific.
33065	7	56				This section is heavily focused on IAM results and seems to ignore any discussion of or integration of bottom up results. For example, the SRREN results in Chapter 10.2.3 and similar discussions for CCS would be necessary to help the reader understand to what extent we can rely on model projections.	Taken into consideration.
21157	7	57	15	57	15	Do you mean in the absence of further climate change mitigation policies? As some policies are already implemented	Accepted. Changes made.
24653	7	57	18	Fig 7-16	25	The results of the integrated assessment models shown in Figure 7-16 and others will show different technology combination projections depending on the underlying technology cost and carbon policy and environmental policy scenarios. To understand the results, suggest that major assumptions/model results are mentioned, for example as an annex or footnote.	Accepted. The main point is that there are multiple pathways depending on a long list of assumptions. A link to the Scenarios Data Base now makes it easier for the reader to access the complete scenarios.
30915	7	57	21	57	39	The response to the FAQ requires revisions to increase its readability and the information provided within. It is also questionable whether key barriers are adequately addressed in this response, including availability of technology, workforce, etc. The response could be more robust.	Accepted - The FAQ 7.4 (now called FAQ 7.3) box has been edited to better pull out key points on barriers.
23609	7	57	6	57	13	Replace those lines by a mere reference to table 6;1	Noted. The reader needs that background material repeated here.
25730	7	57	7	57	9	This part should be revised to "recognized objective of the Cancun Agreement to limit global average temperature change to below 2°C", describing the Cancun agreement correctly. This target is not agreed but only politically mentioned. In addition, the 2℃ target is extremely difficult to attain, as described in (Höhne, 2011, conclusion) and (Rogelj, 2011, abstract). These literatures are listed in the No4 line of this table.	Accepted. Language revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
23317	7	58				Is the top "total" figure really needed? What is the definition of "non-electricity"? Is it heat or heat plus transport fuels?	Taken into consideration. This refers to total emissions from all energy users including those in emissions originating in end-use sectors.
21871	7	58	10	58	15	This is a major shift of emphasis from the energy sector to the energy system (including end-use and demand assumptions). It's a big shift which should be made very clear, or following earlier recommendations, should be moved completely from this chapter to a cross-cutting integrative chapter (e.g., Chapter 6?) as its arguments are fundamentally linked to an understanding of energy demand (which is not covered here).	Accepted. We agree that the shift must be emphasized. The point of Section 7.11 is to understand the implications of the more complete results of Chapter 6 fore energy supply and transformation. Having said that the simple fact that every joule of energy that was consumed by the end use sector was produced by the energy supply sector and therefore the totals have direct implications for this chapter. The necessity to take the interaction between demand and supply side options into account now is emphasized in 7.1 (introduction).
21870	7	58	3	58	8	Useful to include the RCPs on these graphs. More substantially, the graphs in Figure 7.15 suggest that electricity is approx. 1/3 of total energy system emissions (should be energy sector emissions following earlier arguments about terminology), but earlier Fig 7.3 & 7.5 suggest approx. 70% is electricity + heat ... so does this mean heat is responsible for approx. 1/3 of total emissions? More generally, Figure 7.15 right lower panel (non electricity supply) sharpens the lack of emphasis given to the non-electricity supply throughout the chapter.	Accepted. The suggestion to include the RCPs is a good one. We tried to be clearer particularly with regard to 7.3 and 7.5
21873	7	59	11	59	14	This is an absolutely critical point about the importance of energy demand reduction as a prior consideration to thinking through energy supply mitigation options. In other words, mitigation portfolio design, uncertainty and robustness is dependent on progress made in reducing energy demand.	Accepted.The necessity to take the interaction between demand and supply side options into account now is emphasized in 7.1 (introduction).

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25174	7	59	11	59	14	Recommend rewrite to exclude assumption of offset. Otherwise, citation of offset required here. See comment on Chapter 7 entitled: **Implicit assumption of renewable energy mitigation potential are not supported by recent empirical, behavioral, and macroeconomic analyses	Rejected - reported are the results of business-as-usual or mitigation scenarios that try to stay below some given concentration level. The integrated assessment models used to derive the scenarios do not make assumptions about replacement. They simply give the mix of option which allows to fulfill the goal (often by trying to do so in a cost-effective manner). The question, which policies are needed to obtain these scenarios is another one. In the policy design, the issue of a potentially restricted offset (or potential rebound effects) is to be taken into account.
21872	7	59	8	59	10	My understanding of the MESSAGEis that efficiency and demand-side improvements are exogenous or part of the scenario set up, whereas this implies that they are endogeously generated to replace fossil fuels.	Noted. MESSAGE now includes end-use energy technology as an endogenous part of the model's calculations.
31432	7	6	1	6	44	It should be noted that gas-insulated transmission lines might have significant climate effects due to emissions of SF6 (the highly potent climate gas commonly used in such lines).	Rejected - the severe space constraints of the ES do not allow for this level of detail.
24630	7	6	1	6	4	Suggested flag that a large proportion of the 2 billion people without access to modern energy sources and services will be more cheaply and quickly satisfied by small to medium scale distributed energy and energy efficiency solutions than by centralised systems. Indeed, many who are on the fringes of existing grids would be better off disconnecting. Suggested citations: Goldenmberg, J., Johansson, T.B., Reddy, A.K.N. and Williams, R.H. (1987). Energy for a sustainable world. World Resources Institute, September 1987. (http://pdf.wri.org/energyforsustainableworld_bw.pdf) [This 1987 study actually shows that the developing world could reach mid 1970s European living standards while roughly doubling energy use: but the forms of energy shift to modern carriers such as electricity, and to renewable energy such as high efficiency use of biomass, so that energy related emissions would increase by very little] Geller, H. (2003). Energy Revolution: Policies For A Sustainable Future. Island Press, 2003, ISBN: 1559639652, 9781559639651, 289 pages	Taken into account - there is now a statement treating the infrastructure issues related to developing countries.
19050	7	6	1	6	4	"key challenge to deliver modern energy services --- disseminate low carbon technologies --- massive technology transfer coupled with financial support". I asume that you mean providing electicity as modern energy services? Biomass is a renewable 'high' carbon energy. The phrase should be modified to 'low non-fossil fuel carbon technologies. Rural people know how to grow plants, what they need is some financial support, training and assured markets, not massive technology transfer!	Taken into account - there is now a statement treating the infrastructure issues related to developing countries.
26072	7	6	13	6	19	Lumping renewable energy sources, CCS and nuclear energy together as low-carbon technologies does not allow the necessary differentiation in this paragraph, as the social acceptance for these technologies is extremely different. Please, differentiate and address each of the three options seperately.	Accepted - text revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36719	7	6	20	6	24	The message of this paragraph is not clear. Suggest rephrasing the paragraph with the following: "Integrated analysis tools and modelling frameworks are required to better support integrated decision making. These include accounting for the range of possible co-benefits and trade-offs of different policies that tackle access; security and/or environmental concerns; as well as governance, institutional and human capacity for the use of such tools and frameworks. [7.9, 7.10; medium agreement, medium evidence]"	Taken into account - comment is obsolete as the underlying text has been deleted.
36720	7	6	20	6	24	This statement appears to be neither accurate nor supported by text in 7.9 and 7.10. Suggest instead the message that tradeoffs should be considered in making decisions about energy, and that governance, institutional and human capacity to consider tradeoffs (however it is done) is necessary. While integrated analysis tools and modeling frameworks are one way to accomplish this goal, consideration of tradeoffs does not necessarily require them (and the history of their use suggests that their value is very much dependent on the nature of the decision-making process itself). A policy requiring that affected stakeholders be consulted in the energy policy-making and deployment process, for example, accomplishes a great deal towards the same end without requiring the implementation of costly and complex technology solutions. This is pointed out in terms of increasing social acceptance in the previous paragraph (l. 13-19) but should be made explicit in the discussion of tradeoffs.	Taken into account - comment is obsolete as the underlying text has been deleted.
26073	7	6	27	6	31	If renewable energy sources are considered as a single technology option, as they are regularly treated in integrated assessment models, this statement does not hold. Renewable energy sources can transform supply and transformation systems to meet long-term low stabilization goals. See for example the report of the Council of Environmental Advisors to the German government (Pathways to 100% Renewable Electricity Supply, 2011), which shows this option for Europe and North Africa. The report is available on the internet. See your own text on page 19 of chapter 7 in line 8 to 10 it is stated that in each region of the world the technical potential of RE as a whole is at least 2.6 times as large as 2007 total primary energy demand.	Taken into account - comment is obsolete as the underlying text has been deleted.
21771	7	6	3	6	3	Dissemination is a very odd choice of word for diffusion / uptake of low carbon technologies and implies a very top down view of technology transfer (effectively excluding trade, FDI, inward investment, etc.)	Taken into account - there is now a statement treating the infrastructure issues related to developing countries.
19051	7	6	32	6	33	"As many RE technologies are still not competitive ---". Traded biomass is very competitive. This should be encouraged as it supplys many jobs and increases rural income. Especially so if using biomass for CCS.	Rejected - the original text used the word "many" not "all" and providing counter examples will lead to much debate over which specific technologies are economically competitive today, and in which locations and conditions. The space does not exist to go into this level of detail.
23253	7	6	32			Change "many" to "some" (hydro, biomass heat plant, solar water heaters, and solar PV when displacing diesel gensets in remote islands etc) - and add after "need" "under some circumstances" . Are a large number of RE heat and power plants (hydro, bioenergy, geothermal) in place operating without support.	Rejected - the majority of the RE that could contribute to the achievement of stringent stabilization goals will need support in order to do so. Those which are competitive today are often already in use.
20249	7	6	32	6	37	KEEP this para as it is important summary for policy makers regarding renewable costs.	Noted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36721	7	6	32	6	33	The need for financial support for RE related here and value of such support (while real) is not well-supported by the text in 7.8-7.10. Suggest adding some discussion in 7.8 of the relationship between such policies (including both deployment support mechanisms like feed-in-tariffs and direct cost-reduction measures like government R&D funding) LCOE reduction, and deployment.	Taken into account - the text in 7.12 has been improved accordingly.
40686	7	6	32	6	37	Important point. Please maintain these sentences.	Noted.
27759	7	6	32	6	33	Right now this sentence implies that the mitigation options are associated with additional costs in comparison to a Business-as-usual scenario. This is not necessarily true. The issue could also be framed as follows: Direct and indirect subsidies for fossil fuels need to be abolished and external costs of conventional energy conversion technologies need to be internalised.	Taken into account - text is revised to improve clarity. The phase out of fossil fuel subsidies is mentioned explicitly in another statement,
25163	7	6	32	6	33	The referenced sections do not show that there "is a need" or why it is desirable to "increase their market share" See comment on Chapter 7 entitled: **Implicit assumption of renewable energy mitigation potential are not supported by recent empirical, behavioral, and macroeconomic analyses	Rejected - the sentence does not speak about a need to increase the market share. It speaks about what is necessary in CASE that the market share should be increased.
24290	7	6	33	6	35	"The same is and will be true for CCS plants due to the additional equipment attached to the power plant and the decreased efficiency." CCS seems not "the same" with RE, since RE brings more benefits than CCS from aspects of power generation, multi- pollutants reduction and manufactoring promotion, which may cause defferences in the direct or indirect financial support between them.	Accepted. - text revised.
31529	7	6	33	6	35	"The same is and will be true for CCS plants due to the additional equipment attached to the power plant and the decreased efficiency." CCS seems not "the same" with RE, since RE brings more benefits than CCS from aspects of power generation, multi- pollutants reduction and manufactoring promotion, which may cause defferences in the direct or indirect financial support between them.	Accepted - text revised.
30070	7	6	33	6	34	I do not agree!	Noted. It is not clear what change is being requested.
30540	7	6	33	6	33	It is clear that clean energy will always need subsidy as we now know that we can access vastly more fossil fuel than we can possibly emit to atmosphere and hence eventually fossil prices must go very low. This is a clear change since AR4 and I think a key theme.	Rejected - We are not sure what specific changes are requested here, and also do not agree that "it is clear that clean techs. will ALWAYS be more expensive." Fossil resources were known to be large in AR4 as well. Clearly, if carbon emissions reductions are the goal, policy intervention seems essential, and this point is made elsewhere in AR5 as it was also in AR4. We are not certain what other specific suggested changes are desired here.
30071	7	6	36			(… power) is mixed replaced for seems to be problematic	Noted - it is unclear what the reviewer suggests.
36722	7	6	42	6	42	The word "hence" is misplaced since B does not follow from A -- the Cancun agreement makes no reference to 450 ppm.	Accepted - revisions made to clarify text.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21772	7	6	43			Add immediately to: Additional mitigation policies must be enacted if the Cancun Agreement is to be fulfilled.	Rejected - the scenarios in 7.11 shows that there is some temporal flexibility in doing so.
29634	7	6	5		8	There are examples of Biogas models particularly but not only in India, where mitigation technology can be user-friendly and provide livelihoods to urban poverty communities. Through Nisargaruna Plants with BARC technology, women wastepicker's group in India can process 250 kg of organic materials empoying 3 workers. Their waste management system, mitigating climate change and creating jobs, are seing run successfully at 40 places in many wards of Mumbai and Navi Mumbai. While proportion 250kg-3 workers is a job-creation strategy, there are other biogas technologies employing same people (3) for 25 Tons a day (Sacramento, US, cleanworldpartners.com). Its strongly recommended to invest in small scale-decentralized and labour intensive plants. More information available at http://streemuktisanghatana.org/activities/parisar-vikas/	Noted - no textual change seemingly needed, as this is too much detail for the chapter
35483	7	6	5		8	The example of the biogas technology Nisargruna Biogas Plant should be taken into account.The plant was developed to convert on-site organic waste (almost any biodegradable waste including kitchen waste, paper, animal dung, bio-sludge, poultry manure, agro-waste, and biomass) at an individual institution or apartment building into useful methane and high-quality manure (fertilizer) to then be sold back to households or local businesses. The benefits: a. Only 50 m2 are required for a plant that processes 100 kg per day. b. The resulting biogas is 85 percent methane, more efficient than the 50 percent methane typical of most biogas plants. c. The largest part of the waste stream –organics- can be processed and used very close to where it is produced. d. Small footprint, lack of odors, and direct use of biogas for heating e. Avoids the pollution that results from landfilling wet waste. See the complete case study in 'On the road to zero waste. Successess and Lessons from Around the World, by GAIA Global Alliance for Incinerator Alternatives, 2012.	Noted - no textual change seemingly needed, as this is too much detail for the chapter
36717	7	6	5	6	5	Suggest deleting "often."	Rejected - the qualifier is important.
30539	7	6	5	6	24	I think this is unnecessary and could be removed	Taken into account - the second and third paragraph have been removed due to space constraints. The first one, however, is important, and has to stay.
26991	7	6	5		8	The example of the biogas technology Nisargruna Biogas Plant should be taken into account.The plant was developed to convert on-site organic waste (almost any biodegradable waste including kitchen waste, paper, animal dung, bio-sludge, poultry manure, agro-waste, and biomass) at an individual institution or apartment building into useful methane and high-quality manure (fertilizer) to then be sold back to households or local businesses. The benefits: a. Only 50 m2 are required for a plant that processes 100 kg per day. b. The resulting biogas is 85 percent methane, more efficient than the 50 percent methane typical of most biogas plants. c. The largest part of the waste stream –organics- can be processed and used very close to where it is produced. d. Small footprint, lack of odors, and direct use of biogas for heating e. Avoids the pollution that results from landfilling wet waste. See the complete case study in 'On the road to zero waste. Successess and Lessons from Around the World, by GAIA Global Alliance for Incinerator Alternatives, 2012.	Noted - no textual change seemingly needed, as this is too much detail for the chapter

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26071	7	6	8	6	12	Statement does not hold true for nuclear energy. Location specific negative impacts of severe nuclear accidents can not be mitigatate in a sufficient manner by design and siting.	Accepted - nuclear is taken out of the paragraph.
36718	7	6	9	6	9	It would help the reader, especially policy-makers, to give at least one example of "technology and location-specific negative impacts".	Rejected - space constraints do not allow for examples at the level of the executive summary.
25162	7	6	9	6	11	Section 7.9 does not show that RE technology negative impacts can be mitigated. It shows how little is known about these effects and how difficult they are to quantify.	Taken into account - the underlying text has been improved in order to better support the statement.
20070	7	6	33			Replace "in order to" with "if there is an intention to" of SPM (p.17 line25) to be more precise.	Accepted - text revised in the ES.
27051	7	6	13			Delete 'low carbon'. The statement relates to all energy projects, regardless of their carbon content. It is not only an issue for 'low carbon', whatever these are. Again, define 'low carbon' somewhere in the report or use terminology that is generally understood and well defined.	Taken into account - comment is obsolete as the underlying text has been deleted.
27052	7	6	32			Comparing levelized cost with energy prices is comparing apples and oranges, because energy prices are to a great extent a function of policy, rather than technology costs. Levelized cost of many conventional technologies are higher than existing energy prices in many markets. In a section that seems to describe the competitiveness of the various technologies it is confusing that electricity prices (which are often subject to taxes, regulation or other politically motivated tampering) enters the picture. In the UK, current cost estimates of building new nuclear enegry is reported to be set at around £140/MWh ($US 210/MWh) for two new reactors at Hinkley Point, according to EDF (see for example http://www.telegraph.co.uk/finance/newsbysector/energy/9470555/EDF-chief-Vincent-de-Rivazs-nuclear-vision-aims-to-inspire-a-generation.html) - higher than offshore wind (reported at app. £90 in the current UK discussions) and much higher than new onshore wind energy. If the authors insist on referring to solar and wind cost in the (short) section on renewables - something that is not done for any other of the technologies mentioned in the Executive Summary - the comparisons must be made relative to the alternatives. As the Summary reads now, it hints (contrary to increasing evidence) that no renewable energy source beats conventional power sources. (some) RE technolohies are still expensinve.	Taken into account - text paragraph has been rewritten in order to address the reviewer's concern. A comparison with energy prices is avoided. From a policy point of view, the interesting issue is whether and which low carbon technologies need support, if they should become part of a portfolio which is able to result in GHG concentration stabilization.
24631	7	6	5	6	12	This paragraph is well written and sets out an important concept. It should be kept if the chapter is shortened	Noted.
31629	7	6	8	6	11	Long sentence would beneift from restructuring	Accepted - text revised for clarity reasons.
25624	7	60				In the MESSAGE and ReMIND on the right side, nuclear power ratio is declining. If this is results from the some kind of given conditions to the model, such remark should be added.	Taken into consideration. The purpose of this section is to illustrate that depending on many assumptions, that a variety of pathways have been found to the same end. While we could produce more detailed descriptions of the circumstances that give rise to the result, the ability to explain the reasons that the models produced their results is limited.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24301	7	60				The oil with CCS is not mentioned in previous text(cf.figure 7.9 and section 7.5.5). The oil w/ CCS should be deleted.	Rejected. The fact that oil with CCS is not mentioned in the previous section does not mean that the technology does not exist nor does it mean that the result does not occur in the literature. If anything, the comment should be that the application of CCS technology to oil combustion needs to be added to the earlier sections.
31540	7	60				The oil with CCS is not mentioned in previous text(cf.figure 7.9 and section 7.5.5). The oil w/ CCS should be deleted.	Rejected. The fact that oil with CCS is not mentioned in the previous section does not mean that the technology does not exist nor does it mean that the result does not occur in the literature. If anything, the comment should be that the application of CCS technology to oil combustion needs to be added to the earlier sections.
20505	7	60				y-axis description is missing. Probably EJ?	Accepted. Units are added to the figure. Note that units are given in the figure title and are indeed, EJ.
25731	7	60				In this figure, there should be an explanation about the reason why the ratios of nuclear power generation are same in the 550 ppm case and the 450 ppm case. It seems that the capacity and/or generation of the nuclear is intentionally limited and set as the same in both cases. Many assessment models assume the limitation of nuclear power capacity and/or generations considering the public acceptability. It seems that the results are based on this assumption. If so, the results underestimate the contribution of nuclear power in terms of mitigation costs.	Noted. the two cases are a reference, no additional climate policies, and a 450 ppm co2-e limit scenario. There is no 550 ppm scenario in the figure. Nuclear power production competes on the basis of economic cost in the GCAM model and its penetration is not constrained in either the reference or policy. Other scenarios may make different assumptions, but the point of the three figures is to demonstrate that a variety of pathways to the same outcome are possible.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19080	7	60				CCS for biomass. I am very sceptical about storing emissions from biomass and from other forms of energy. It may be far cheapter and longer-lasting to expand the area and promote better species/clones.	Noted. The balance of technology choice between terrestrial sequestration and bioenergy with CCS and other technological options, depend on assumptions about technology and cost. GCAM, for example, has substantial deployment of terrestrial sequestration, which is not discussed here as this is a chapter focused on energy production and transformation. However it should be discussed in Chapter 6 and in the land-use chapter. This comment is essentially a recommendation of policy choice.
23318	7	60				Y-axis labels missing	Accepted. Note that units are now given in the figure and are indeed, EJ.
36881	7	60	1			Please label the y axis	Accepted. Note that units are now given in the figure and are indeed, EJ.
19081	7	61				Methanol may be a cheap and practical way to store hydrogen	Taken into account. Yes, though this is probably not the place to discuss the specific technology option.
23319	7	61				This figure hard to interpret. Where is heat? Why does "gas w/o CCS" not have a trend arrow? Is it assumed to be static? - yet the mean bars don't show that. Not clear what point the figure is trying to illustrate.	Accepted. Figure revised.
25175	7	61				Figure 7.17 is open to various critiques. It compares energy potentials of varying qualities. For instance, it displays hydropower, which is a dispatchable supply against wind power, which is not dispatchable. To make a transparent comparison, intermittent sources would have to be adjusted for storage or concurrent fossil fuel supply. Figure 7.17 compares fuels that are dense, storable, portable, fungible, and transformable against others that are not characterized by such qualities, or are characterized as such to a different degree. Figure 7.17 compares energy carriers against primary energy sources. Hydrogen is not an energy source but an energy carrier and should not be compared to natural gas.	Accepted. Figure revised.
26913	7	61	1			It's not clear what the large red upwards arrow means under "Liquids/Hydrogen."	Accepted. Figure revised.
36882	7	61	1			This figure is very difficult to comprehend; either it needs a better caption, or should be redesigned.	Accepted. Figure revised.
20252	7	61	12	63	23	KEEP this para as it is important summary for policy makers regarding energy systems. Move this para to SPM. "electrification of end use sectors is a way fo reducing GGH emissions.	Accepted. Changes made.
23757	7	61	14	61	14	Should read: "originally traditional biomass dominated energy system in the 19th century".	Accepted. Changes made.
33790	7	61	16			… database) have three generic …	Accepted. Changes made.
21158	7	61	16	61	16	typo: should be have instead of has	Accepted. Changes made.
23320	7	61	18			Change "Chapters 7 and 8" to "7and 9" and "sometimes transportation" to " in part, for transport fuels (Chapter 8)"	Accepted. Changes made.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36883	7	61	18	61	23	Should be explicit about where in Chapters 7 and 8. Especially this chapter.	Accepted. Links are now more explicit.
21874	7	61	2	61	6	This is quite a difficult graph to understand (not helped I think by the green arrow overlay having shifted the colours of the underlying bars).	Accepted. Figure revised.
23321	7	61	24		27	Change Chapter 8 to Chapter 9 and Chapter 9 to Chapter 8. Change last 2 sentences to "Biofuels, together with electricity and hydrogen, have the potential to displace a share of petroleum products used for transport." [Last sentence now is meaningless.]	Accepted. Changes made.
27786	7	61	24	61	27	In reality the provision of biofuels is associated with significant emission from fossil sources (fertilizer and pesticide production, processing..). Furthermore, biomass cropping is associated directly or indirectly with land use (change) emissions. These emissions, albeit not stemming from fossil sources, must not be ignored. In conclusion, it is misleading to argue that bioenergy has the "potential to provide transport services without fossil fuel emissions". As this section deals with the role of electricity, we suggest not discussing the complex topic of biofuels at this point. Thus, please delete "Bioenergy and" and the sentence "The relative contribution of each depends at least in part on the character of technologies that evolve to provide transport services with each fuel."	Accepted. We agree that biofuels cannot be understood outside of the context of a fully integrated system model such as the IAMs whose upon which we draw here. Fully integrated models, e.g. GCAM explicitly account for indirect land use change emissions, and/or terrestrial carbon sequestration as well as ancillary emissions associated with all land-use activities, including fertilizer application, and methane emissions which can expand or contract depending on the indirect effects through for example cattle and rice production. We leave for Chapter 6 the job of pulling things together in this way, however the statement of potential remains valid and is substantiated by the literature.
21876	7	61	28	61	33	Repetition.	Accepted. We agree that this point has been made before. However we reiterate it here to remind the reader of the context.
23322	7	61	30			Delete list of renewables - is not necessary.	Rejected - We think it is useful to remind the reader what is meant here.
21875	7	61	7	61	11	The point about regional variation is a key one with reference to mitigation portfolios, and warrants more than a 3 line recognition. Can some of these regional differences - particularly with respect to China - be teased out more explicitly?	Rejected. These lines are very clear and there is no room to get into the requested level of detail.
40695	7	61				Since this sentence is very important for policy makers as this part summarizes knowledge about whole picture o energy system , this part must be maintained.	Accepted. Changes made.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25510	7	61				7.11.3 The role of the electricity sector in emissions mitigation- the detailed information can be summarized into main points rather than developing points more descriptive way, for examaple 1 and 2 paragraphs	Noted. We feel that this point is sufficiently important that it deserves to be elaborated.
25176	7	61				Recommend rewrite to exclude assumption of offset. Otherwise, citation of offset required here. See comment on Chapter 7 entitled: **Implicit assumption of renewable energy mitigation potential are not supported by recent empirical, behavioral, and macroeconomic analyses	Rejected - reported are the results of business-as-usual or mitigation scenarios that try to stay below some given concentration level. The integrated assessment models used to derive the scenarios do not make assumptions about replacement. They simply give the mix of option which allows to fulfill the goal (often by trying to do so in a cost-effective manner). The question, which policies are needed to obtain these scenarios is another one. In the policy design, the issue of a potentially restricted offset (or potential rebound effects) is to be taken into account.
25732	7	61	12			This section should be kept in the final version report because it is important to explain the role of the power sector in emission mitigation. This section indicates that it is important to make electrification rate higher for energy system in order to reduce CO2 emission.	Noted
25386	7	62				Figure 7.18 should be left in this report, as it is a correct estimation that limiting CO2 emissions will increase the share of electricity.	Accepted. Figure is in the report.
24302	7	62				It is suggested to use 2010 as the base year instead of 2008 to keep for consistency purpose.	Accepted. Changes made.
31541	7	62				It is suggested to use 2010 as the base year instead of 2008 to keep for consistency purpose.	Accepted. Changes made.
24303	7	62				It is suggested to use 2010 as the base year instead of 2008 to keep for consistency purpose.	Accepted. Changes made.
31542	7	62				It is suggested to use 2010 as the base year instead of 2008 to keep for consistency purpose.	Accepted. Changes made.
25734	7	62				This figure should be kept in the final version report. The result indicates that the rate of electrification becomes higher, as the CO2 concentration is constrained strictly. This means that it is important to make electrification rate higher for energy system in order to reduce CO2 emission.	Accepted. Figure is in the report.
19083	7	62				"Share of low-carbon energy in total primary energy" Don't you mean low fossil fuel energy?	Taken into account. We include bioenergy as a renewable, "low carbon" fuel. Changes are made to make this more explicit.
23324	7	62				Why a figure on "Liquid Fuels Supply" in this section 7.11.3 on "electricity sector"? Also paragraph page 63 lines 19-23. Delete or change sub-heading.	Taken into account. Liquid fuels supply is included for the contrast. It shows that it is difficult to get carbon out of the liquid fuels that are passed forward, especially to the transport sector, which contrasts sharply with the situation for power.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25388	7	62	11	62	17	As bioenergy is widely recognized as carbon-neutral, I wonder if installation of BECCS is examined in a factual manner. I also doubt that large-scale utilization of BECCS is well underway when the price is about $100/ton CO2. If they are facts, status of examination of BECCS should be described more specifically.	Noted. This result is supported by the cited literature.
25733	7	62	11	62	17	This part should explain that there are many concerns about CCS such as safety confirmation, storage potential, high cost or public acceptance, as described in (Finkenrath, 2011, page7), (Rubin, 2007, page4447, Table3), (Lohwasser, 2012, Abstract), and (Zoback, 2012, Abstract). CCS cost depends on a number of conditions such as concentration of CO2 in the exhaust gases, capture technology, access to storage site, storage potential, and CO2 monitoring. These literatures are listed in the No12 line of this table.	Noted. Please read the section on risk and 7.5.5 on CCS.
23323	7	62	2		5	Caption - "Global share…". Explain what categories C5 to C1 are. Why are the "three" levels of stringency?	Accepted. Changes made.
19082	7	62	6	62	7	"Mitigation studies indicate that the decarbonisation of the electricity sector may be achieved at a much higher pace than in the rest of the energy system)". Again the sentence implies the substitution of all carbon based fuels.	Noted. The sentence is correct as written.
25387	7	62	7	62	10	Suitable sites for renewable energy or CCS are eccentrically-located and installation of them requires great cost. It should be added that there are difficulties to make the world's average emission factor of electricity to zero.	Noted. We believe that we have given a clear indication of the marginal costs by specifying the carbon tax rates that are consistent with various levels of mitigation.
29188	7	62		62		Caption states three different Levels of Stringency, graph shows five, caption needs altering to match graph.	Accepted. Changes made.
36884	7	63	15	63	18	This sentence is very confusing and needs to be rewritten.	Accepted. Changes made.
36885	7	63	19	63	19	"Many scenarios." Which scenarios? The IPCC/IIASA? And/or others? Please provide supporting references.	Noted. This refers to scenarios in the IPCC/IIASA data base. This is true for other scenarios in the open literature as well. We made changes to make this clear.
23325	7	63	20			Change "bioenergy" to "biomass"	Accepted. Changes made.
23326	7	63	23			Change "bioenergy" to "biofuels"	Accepted. Changes made.
21877	7	63	7	63	9	Link back to earlier arguments about lock-in and path dependency.	Noted. That link is made just a short way forward in the text.
29189	7	63	10	63	12	The statement "emissions actually become negative" is not substantiated.	Rejected. This was shown clearly in Figure 7.15.
25980	7	64				figure 7.20 is very difficult to understand; please redesign in another graph or put in larger size	Accepted - design has been considerably improved.
23327	7	64				Liquids supply also appears here as well as in 7.19 - so seems sub-heading 7.11.3 is incorrect and needs amending to "Role of electricity and liquid fuel sectors….." If the liquid fuels discussed here are used here only for diesel generation sets and maybe heating oils (and not for transport), then need to define. At present is confusing what is being discussed. This figure hard to follow. Needs more detailed caption for the reader to comprehend. Colours don't match those in the legends. For example bright blue lines seem to be "Baseline 2020-2030" yet in diagrams on right, they run till 2100. Maybe better to simplify and just show both Category 1 and Baseline in legend and figures for 2010 to 2100. Heading at top makes little sense (what do "composition" and "magnitude" refer to? Whole figure can be improved to become more comprehensible.	Accepted. Changes made.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
22602	7	64				The tri-angle graphs are not sufficient to display the information - please change layout into 2-dimensions	Accepted. Changes made.
26914	7	64	1			It is not clear what the green and blue lines mean. The figure is also illegible (e.g., the boxes to the left). Overall, more explanation of the figure would be extremely useful.	Accepted. Changes made.
21878	7	64	2	64	4	These graphs did not reproduce particularly clearly in my version. It wasn't clear where the start point was (in 2010) and therefore what the directionality of the pathways was. The electricity supply panel seems to show very strong baseline change towards RE, and baseline liquid supply seems to be towards CCS and bioenergy. Why are these changes happening in the baselines?	Accepted. Changes made.
36886	7	64	5	64	6	Consider substituting "near-term" for "short-term" in section title (line 5) - for consistency with text (line 6) and with apparent intent to specify upcoming action.	Accepted. Changes made.
31440	7	64	6	64	9	Please consider to include "net" before "…. emissions to decline to zero" in line 9. Please also consider if this statement is valid.	Accepted. Changes made.
36887	7	64	8	64	10	Needs to be said that CO2 emissions (i) must peak, and (ii) may have to decline below zero: "CO2 stabilization requires emissions to peak, near- to mid-term, and decline to potentially subzero levels, longer term." See also Section 7.11.1 (p. 57, line 23), on peak/decline morphology of stabilizing trajectories. The scnario for concentrations need to be defined to make this case.	Accepted. Changes made.
36888	7	64	9	64	10	"Two important implications of that biophysics follow directly." What does this mean? What does it have to do with biophysics in any case?	Accepted. Changes made.
29190	7	64		64		Legend and text on graphs are illegible.	Accepted. Changes made.
23329	7	65				What do "OPT" and "HST" signify? What do the spokes (radial lines) show? Is the figure needed at all? Doesn't seem to add much than what the text says.	Accepted. Definitions added.
21879	7	65	1	65	22	This is a novel insight and is covered here in too much detail. Most of the text can be deleted; what's needed is the key point that delay increases the magnitude and cost of the mitigation effort. Figure 7.21 seems an overly-complex way of making a simple point about delaying action from 2010-2030 shifts mitigation emphasis to 2030-2050.	Noted. The result is non-trivial. It is not obvious that delay does not shift emissions mitigation paper to later in the century. However, the result is that mitigation is shifted to the very next period, meaning that the challenge is much greater in the 2030 to 2050 time frame.
36890	7	65	1	65	25	Paragraph 3 (lines 10-17) might be better placed immediately after Paragraph 1 (lines 1-4), given their substantive convergence on the concept of a GHG budget/cap - a cumulatively fixed (for given climate goal) but not necessarily annually/pathway-constrained target.	Accepted. Changes made.
36889	7	65	1	65	4	Paragraph under-represents the importance of short-lived climate forcers: Text claims that "no individual year's emissions are critical in determining CO2 concentrations" at the end of the century. This may be true from the perspective of simply assessing cumulative (or average) CO2 levels over the somewhat arbitrary convention of 100 years, but seems to dismiss the potential for short-term (annual) emission pulses to have a cumulative climate forcing effect. Suggest deleting "and therefore no individual year's emissions are critical" from line 2.	Accepted. Changes made.
40696	7	65	12	65	14	As assessed in WG1 SOD (e.g. in Chap.3 p.35 l.51-57, Chap.9 p.10 l.46-5), ocean uptake of CO2 is associated with large uncertainties, such as a possible decline in uptake rates in the future. Furthermore, there exist internationally agreed restrictions on anthropogenic actions with Geoengineering methods to enhance ocean uptake, as discussed in Chapter 13 (page 37 lines 14-32). These uncertainties and constraints should also be contained herein.	Accepted. We will acknowledge the existence of uncertainty.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
23328	7	65	13		17	Soil carbon not mentioned anywhere - maybe the scenarios didn't include it. Need to say so if so.	Noted. We don't mention terrestrial sequestration in this section because that is not the focus of the Energy Chapter. However, we believe that terrestrial sequestration is potentially an extremely important component of an emissions mitigation strategy.
36892	7	65	34			Figure is unclear, especially in its liberal use of like-colored wedges (same color/time frame, different pie slice). What do the wedges represent?	Accepted. Figure improved
36891	7	65	8	65	8	Do the authors mean the "cost of emissions mitigation"?	Noted. No, the authors mean that more emissions mitigation is required as time passes (as measured by the difference between a reference and stabilization scenario).
32422	7	65	11	65	12	While interim pathways may theoretically take on any number, the physics of the climate system limit pathways to plausible options, still providing a very wide possible range.	Noted. That is why we framed the discussion in terms of ghg concentrations, which are more limited in range.
21880	7	66	1	66	18	This is largely repetitious of earlier material (including section 7.11.5)	Taken into consideration. This section (7.11.5) has been deleted and moved to Investment chapter.
21913	7	66	1	66	30	Even though Chapter 16 is dedicated to Investment this section concerns the investment needed in order to move towards a low stabilization scenario. Fund mobilization is probably the largest enabling invervention possible and one that is not considered by current policies.	Taken into consideration. This section (7.11.5) has been deleted and moved to Investment chapter.
20506	7	66	19	67	17	In order to shorten the chapter this can be deleted. The investment volumes can be hardly compared as the table uses too many different different units and the needed investments for energy efficiency are not quatified at all.	Taken into consideration. This section (7.11.5) has been deleted and moved to Investment chapter.
23330	7	66	25			This list is electricity only. Table 7.5 is "Energy investments" and includes "renewables share of total primary energy" which I assume includes heat and transport fuels. Where do heat and transport fuels fit in the discussion? Is transport infrastructure included for example? All somewhat confusing as it stands now.	Taken into consideration. This section (7.11.5) has been deleted and moved to Investment chapter.
19775	7	66	1			The material of this section is useful but should be considered for the investment chapter.	Taken into consideration. This section (7.11.5) has been deleted and moved to Investment chapter.
21881	7	67	1	67	3	The investment numbers on end-use efficiency included in this table are fundamentally misleading as they describe incremental invesments (in the 'efficient' bit of end-use technologies) whereas all the energy supply investment data is for the whole capital stock investment. This serves to hugely inflate the supply-side costs relative to the demand-side costs (and is an inconsistent accounting approach). Investment data on end-use technologies (efficient or otherwise) is scarce, so this row of the table (on investments) should just be deleted to avoid misleading readers.	Taken into consideration. This section (7.11.5) has been deleted and moved to Investment chapter.
21882	7	67	19	67	21	It seems very odd to use DECC 2009 as a reference for this point about multiple objective energy policy when the GEA addressed this in rather a lot of depth!	Taken into account - This reference has been removed and this introductory text in this section has been rewritten.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26808	7	67	19	67	20	Employment, green growth	Taken into account - This reference has been removed and this introductory text in this section has been rewritten.
33060	7	67	21	67	24	The categories of policies introduced here do not match those agreed in Vigo for use across the report. Please reflect those categories that appear in Chapter 3.	Accepted - the section now follows the agreed categories.
36893	7	67	21	67	24	(1) Text refers to, but deviates from, Chapter 15's classification of policy instruments. (2) As the Chapter 15 framework originates in Chapter 3, the latter merits simultaneous reference (as done elsewhere - e.g., see p. 68, line 7). (3) Lines 22-23 vaguely-to-incorrectly use "financial measures" to denote both market-based GHG pricing mechanisms and more technology-specific incentives; while these do generate financial motivations, they are essentially "economic instruments" (as defined in Chapters 3 and 15), rather than elements of dedicated financial policy.	Accepted - text revised.
20507	7	67	25			Here references from China, the EU and India should be included. EU: European Commission, 2011, World and European Energy and Environment Transition Outlook - WETO-T, Bertrand Château and Domenico Rossetti di Valdalbero (Eds.), Publications Office of the European Union, 2011; ISBN 978-92-79-20044-1	Rejected. Detailed country findings are not recommended by the IPCC guidelines as it can be both unfair as well as misleading to focus on individual country circumstances and their subsequent individual country measures and their subsequent individual country policies. However, Chapter 15 does go as far as it can in pulling lessons from specific nations/regions.
33059	7	67				The structure of the section is inconsistent with the agreements made in Vigo, and does not apply the agreed categories of policies as appears in Chapter 3. Please rewrite to adhere to agreements, which will also facilitate cross-chapter integration.	Accepted - the section now follows the agreed categories.
33063	7	67				It would be helpful to link this section back to Section 7.11, particularly e.g. Figure 7.20 clarifying e.g. what policy assumptions are included in the IAMs that allow such results, and how does this reflect what is happening in the real world.	Accepted - the section now start with a direct reference to 7.11 and the derived policy needs.
33064	7	67				In the LDC Box 7.1 on p. 45-46 priority differences in policymaking among countries are highlighted. It would be useful to reflect this discussion in this section as well.	Taken into account - the text now follows a new format highlighting different approaches beyond economic instruments. The discussion of regional differences however is not possible due to space constraints. The detailed discussion is left to chapter 14 and 15.
25735	7	67	18			This section should include "voluntary agreement" of an effective method to improve energy efficiency and reduce GHG emissions, as described in the section 15.5.7.4. There are successful examples of "voluntary target scheme" in the world. Each industry in Japan has voluntary target and the voluntary target scheme has played a big role, as described in (Yamaguchi, 2012, page35 and 154), (Manuel, 2010, page 6 and 13), and (Yamaguchi, 2010, abstract). In addition, there is also a successful example of "voluntary target scheme" in Netherlands, as shown in (Martijin, 2002, page162). These literatures are listed in the No22 line of this table.	Taken into account - voluntary agreements now are discussed.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24304	7	67	19	68	3	The efect and importance of the policies in differential countries are different due to the different load characteristic.(Fredrich Kahrl et al. 2011)Fredrich Kahrl, Jim Williams, Ding Jianhua, Hu Junfeng. 2011. Challenges to China's transition to a low carbon electricity system, Energy Policy, 39(7): 4032-4041.	Taken into account. While no country specific findings are included here, Chapter 15 does go as far as it can in pulling lessons from specific nations/regions.
31543	7	67	19	68	3	The efect and importance of the policies in differential countries are different due to the different load characteristic.(Fredrich Kahrl et al. 2011)Fredrich Kahrl, Jim Williams, Ding Jianhua, Hu Junfeng. 2011. Challenges to China's transition to a low carbon electricity system, Energy Policy, 39(7): 4032-4041.	Taken into account. While no country specific findings are included here, Chapter 15 does go as far as it can in pulling lessons from specific nations/regions.
26626	7	68				CCS has been approved as eligible CDM activity and this may be remarkable new develoment scince AR4 publishment.	Accepted - text revised.
24654	7	68	10	68	12	Australia should be included in the category of countries with emissions trading schemes in place	Taken into account. The comment is obsolete as the relevant paragraph has been deleted. The list of countries is given in Chapter 15.
24408	7	68	12	68	12	Note that Australia has implemented a AU$23/tonne of CO2 carbon tax.	Taken into account - tax schemes now play a more prominent role, but single countries are only mentioned in Chapter 15 (as is the case for ETS).
36895	7	68	16	68	17	Recommendation to change "trajectories" to "caps." Emission trading/cap-and-trade policies set ex ante caps, without necessarily constraining the underlying annual trajectory - frequently allowed to deviate from the nominal cap, as a function of temporal (banking/borrowing) flexibilities and/or other compliance options (like offsets), and thus only known ex post.	Taken into account. The comment is obsolete as the relevant paragraph has been deleted.
36896	7	68	16	68	25	This paragraph is difficult to decipher.	Accepted - the paragaph has been restructured considerably. Parts were deleted.
34336	7	68	18	68	20	Please cross-reference section 7.10.	Taken into account. The comment is obsolete as the relevant paragraph has been deleted.
20308	7	68	26	68	28	On a more critical assessment on the effects of the EU ETS see e.g. Kettner, C., Köppl, A., Schleicher, St., Thenius, G., (2008), Stringency and distribution in the EU Emissions Trading Scheme: first evidence, in: Climate policy 8 (2008), 41-61; Kettner, C., Köppl, A., Schleicher S, (2012) Carbon Authority as Price Stabilising Institution in the EU ETSduction Targets and their distributions [Wifo-Monographien, 6/2012, 21 Seiten]. A working paper for the project ICPIA funded by the Austrian "Klima- und Energiefonds".	Taken into account - Kettner 2008 now is added to the reference list. Kettner 2012 not as it is not peer-reviewed.
21159	7	68	26	68	28	Backfire effect has been observed in 2013	Rejected - although the concept of backfire is known as part of the rebound effect, the meaning of the term applied to the ETS as applied here is unclear.
23331	7	68	26		28	Need to include discussion on low C prices experienced in recent times - not just cite one reference from 2010.	Accepted - paragraph on low carbon prices is added.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
36897	7	68	29	68	33	Paragraph notes absolute impact of a GHG price on fossil-fired electricity (higher marginal cost); should further stress relative, fuel-differentiated impacts across the generation mix - recognizing that it's largely the shift in technologies' relative competitiveness, based on GHG intensity, that drives transformational change.	Accepted - text revised. The fuel dependent impact on the marginal costs now is discussed.
33791	7	68	3			… increased if the Cancun …	Editorial
36894	7	68	3	68	3	"increasded" is misspelled	Editorial
21885	7	68	32			This is the first mention of price elasticity in the whole chapter (I think) which is possibly not surprising given the energy supply emphasis, but it would be useful and interesting to know what the price elasticities of demand are for different energy carriers / products, and what this tells us about the effect of mitigation options which may raise prices.	Taken into account. The comment is obsolete as the relevant paragraph has been deleted.
21884	7	68	45	68	46	I don't know what proportion of RE projects in developing countries in the last 5 years have included some CDM financing, but I'm guessing it's very small. If this is true, this statement is rather overexaggerated. Figure 7.22 provides detail which is of marginal importance - recommend delete.	Taken into account - Commentator is not correct, as share of CDM in renewable energy projects in developing countries has been significant. Spalding Fecher et al (2012): Assessing the impact of the Clean Development Mechanism (p. 91, 95, 96), the lion's share of wind power and a significant share of biomass power projects in developing countries are registered as CDM. However, due to space constraints the CDM part has been reduced considerably in 7.12; Figure 7.22 was deleted.
21883	7	68	5	69	7	This section on GHG pricing policies is very weighted towards emissions trading and the ETS in particular. (The many regional / state / national carbon tax systems are not discussed in any detail, nor in a comparative sense with the quantity-based approach of trading schemes). Are policies not covered elsewhere in WGIII? It would be good to move policy analysis to there - as is, this section seems rather tacked on the end a bit half-heartedely. The electricity sector emphasis is again fairly blatant here (at the expense of other energy sector mitigation options) - particularly when the ETS does not just cover the elecricity sector.	Taken into account - the taxes now play a more prominent role. Note that non-electricity policies are discussed in the buildings, transport and industry chapter.
19084	7	68	5	68	5	Because the use of biomass is relatively inefficient, this should have priority for global investments into end-use efficiency improvements.	Rejected - outside the scope of the chapter. End-use energy efficiency is discussed in the end-use sector chapters.
26819	7	68	7			Consider for inclusion- Non-inclusion of externalities, or the environmental and social costs of production,suppress the cost-competitiveness of low-carbon technologies, RETs in particular, thereby acting as a fundamental overarching barrier to investments. "IRENA (2012), Financial Mechanisms and Investment Frameworks for Renewables in Developing Countries (pg. 56), http://www.irena.org/DocumentDownloads/Publications/IRENA%20report%20-%20Financial%20Mechanisms%20for%20Developing%20Countries.pdf"	Accepted - reference added.
25590	7	68				J. Oda and K. Akimoto, "An analysis of CCS investment under uncertainty," Energy Procardia, 4, 1997-2004, (2011) analyzes relationships between carbon price and CCS investment, and concluded that carbon price volatility requires higher carbon price for CCS implementation than that without volatility. Please add this point in the discussions on emission trading schemes.	Accepted - text revised. The reference is added.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33061	7	68				While it is useful to highlight the effect of GHG pricing policies on the energy sector, it would also be helpful to refer to the broader discussion of these policies in Chapter 15.	Accepted - text revised.
23365	7	68	23	68	23	Specific: reference to the Editorial by Grubb et al. (2006) could be supplemented by the paper Grubb et al refer to, i.e. Neuhoff et al. (2006); other key references to make this point are: Åhman et al. 2007 and Ellermann ; finally, the citation to Grubb et al. Is incomplete; a) Grubb M., R. Betz, and K. Neuhoff (Eds.) (2006). National Allocation Plans in the EU emissions 6 trading scheme: Lessons and Implications for Phase II. Climate Policy Vol 6, No.4 , Earthscan, London; b) Neuhoff, K. et al. (2006) c) Åhman, M., Burtraw, D., Kruger, J. & Zetterberg, L. (2007). A Ten-Year Rule to guide the allocation of EU emission allowances. Energy Policy, 35, 1718-1730. d) Ellerman, A.D. (2008). New entrant and closure provisions: How do they distort? The Energy Journal 29 (Special Issue in honor of Campbell Watkins): 63-76. e) Neuhoff, K., Ahman, M., Betz R., Cludius, J., Ferrario, F., Holmgren, K., Pal, G.,Grubb, M., Matthes, F., Rogge, K., Sato, M., Schleich, J., Tuerk, A., Kettner, C.,Walker, N., 2006, Implications of announced Phase 2 National Allocation Plans for the EU ETS, Climate Policy, vol. 6, no. 4, pp. 411-422.	Accepted - additional references are added.
23366	7	68	24	68	25	Specific: the report now states that "all allowances are auctioned to the power sector in most European countries." In fact, the auctions are open to all - not just to the power sector. It may be more accurate to say: installations in the power sector no longer receive allowances for free in most European countries.	Accepted - text revised.
27787	7	68	4	69	11	Rating GHG pricing policies as sectoral policies seems strange. Usually, GHG pricing policies are rated as generic instruments. It does not fit to taxonomy used in Chapter 15.	Accepted - the policy mix that is needed to facilitate transformation of a sector needs to be looked at in a comprehensive manner, including the role of GHG pricing. This does not imply that GHG pricing does not warrant careful assessment from cross-sector perspective.
23364	7	68	8	68	10	Specific: Zhang and Wei, seems an odd key reference for the EU ETS; could at least add Ellerman et al. (2010) (which is also referenced elsewhere in the chapter)	Taken into account. The comment is obsolete as the relevant paragraph has been deleted. The list of countries is given in Chapter 15.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32494	7	689		690		The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Noted. Thank you very much for the additional references.
20508	7	69				y-axis description is missing.	Taken into account - comment is obsolete as Fig. 7.22 has been deleted.
24655	7	69	1	69	3	Use of the word "proving" is misleading - the CDM project needs to establish to the satisfaction of independent auditors and verifiers as well as the CDM Executive Board that the project is additional. There is no "standard of proof" in the CDM. Suggested alternate wording: "...and difficulties with establishing the additionality of projects to the satisfaction of independent auditors and verifiers as well as the CDM Executive Board."	Taken into account - comment is obsolete as underlying text has been deleted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
31680	7	69	12	69	12	According to the Australian Government DCCEE their emissions trading scheme is operating (http://www.climatechange.gov.au/government/international/global-action-facts-and-fiction/ets-by-country.aspx)	Taken into account - the comment is obsolete as the detailed description of those countries which have an emission trading scheme is left to chapter 14 and chapter 15.
23332	7	69	12	70	4	Needs updating on FITs (several amended recently). Needs cross referencing (and cross checking) to the policy chapters.	Taken into account - the cross referencing is carried out; the country list is deleted due to space constraints. Section 7.12 is not the place, where a detailed listing of countries is to be given.
21886	7	69	13	69	14	The point about cost-competitiveness is probably most applicable to CCS and nuclear than to RE, so this choice of emphasis seems misleading. Electricity emphasis again.	Accepted - different cost structures now are considered.
20510	7	69	14			market energy prices: It would be worthwile mentioning that these "market" prices are distorted by energy subsidies in a lot of countries (see IEA subsidy report).	Taken into account - comment is obsolete as market prices are not mentioned any longer. In addition, subsidy removement is addressed explicitly later in the section.
26813	7	69	18			Consdier for inclusion- These policies facilitate the process of bringing RE technologies down the development cost curve through targeted interventions and, in some cases, appropriate deregulation of local RE markets. "IRENA (2012), Financial Mechanisms and Investment Frameworks for Renewables in Developing Countries (pg. 41), http://www.irena.org/DocumentDownloads/Publications/IRENA%20report%20-%20Financial%20Mechanisms%20for%20Developing%20Countries.pdf"	Accepted - text is included.
36898	7	69	18	69	19	Suggest changing "..escalated growth of RE energies" to "escalated growth in deployment of RE technologies".	Accepted - text revised.
21887	7	69	20	69	24	The formulation of technology goals (roadmaps, plans, etc.) is not just about shared expectations but also stability, confidence, consistency and so forth.	Taken into account - unfortunately entire paragraph needed to be removed due to length constraints.
21888	7	69	25	69	33	Strong bias in RD&D portfolios towards nuclear is important to emphasise. Nuclear continues to absorb around half of public RD&D budgets, and this is for a technology which - as noted earlier in the chapter - is commercially mature. The point on page 70, lines 3-4 about nuclear and CCS RD&D fails to mention RE RD&D entirely. Consistency is desperately needed in how the different mitigation options are reviewed and analysed.	Accepted - text is revised accordingly.
21213	7	69	27			Change to "fulfillment"	Noted - comment unclear - what needs to be changed?
20511	7	69	29			The Battele Institute publishes annualy the Global R&D Funding Forecast (2013: http://www.rdmag.com/sites/rdmag.com/files/GFF2013Final2013_reduced.pdf). There the figures from the past and current forecasts are given: Industrial R&D in the energy sector comprises a broad portfolio of technologies, including fossil, nuclear, and renewable generation; smart grid or other transmission and distribution; and energy-efficiency technologies. Worldwide industrial spending on energy R&D is forecasted to increase by roughly 10% from $ 15.7 billion in 2012 to $ 16 billion in 2013.	Accepted - source and parts of the text are included.
21212	7	69	3			Change to "increased"	Editorial
20509	7	69	3		11	The information given is low and this part could be deleted.	Taken into account - figure 7.22 and explaining text now is deleted.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
25389	7	69	34	70	2	It should be added that FIT system can impact civil life and economic activities by rise in the price of electricity and full consideration of such impacts is required in the FIT policymaking process.	Accepted - the paper of Frondel is cited.
21914	7	69	34	70	2	FiTs are often found to be the most successful incentive every applied for the promotion of renewable energy. The key isssue at hand is integration of FiTs across regions rather than holding them to a national level.	Rejected - outside the scope of the chapter. Regional cooperation and design question of policies are to be addressed by chapter 14 and 15, respectively.
20512	7	69	36			states? Of which countries?	Accepted - state numbers are deleted to avoid confusion.
36899	7	69	36	69	36	Are these 27 states within the 65 countries? Are they in one country?	Accepted - state numbers are deleted to avoid confusion.
30546	7	69	39	69	39	FiTs really are a thing of the past. There are fine for delivering a small protected part of the market but they create perverse incentives and poor system design if applied at large scale. Studies that say that FiTs are low cost do not account for the mayhem they create in the rest of the market.	Taken into account - the recent tendency to tender-based systems now is acknowledged. Additional arguments of the reviewer were not supplemented by references on which they are based.
24656	7	69	5	69	7	Statement that the "projected credits by 2020" and the "credits issued by 2012" are "likely to increase" is not based on any evidence. Given low CER prices and uncertainty about the mitigation ambition of developed countries, it is unclear how the CDM project participants will respond. Suggest deletion of first half of sentence so that it reads: "Energy systems-related projects are slower in their implementation than projects in the industrial sector."	Accepted. Text on forecast CER volumes has been deleted
24657	7	69	37	70	2	The quotation cited to be from p869 of the SSREN is inaccurate. It inaccurately portrays the language in the executive summary on p869 to clearly privilege FiTs over quota schemes (such as Australia's RET scheme) as more efficient and effective policies, whereas the more nuanced actual language indicates that there is no one-size-fits-all policy, and that the mix, and their implementation are also important. Suggest either rephrase and remove quotation marks to improve accuracy; or remove the reference altogether.	Accepted - the quotation was taken direct form the main text (p. 903). It is now replaced by the accurate quotation taken form the executive summary.
33062	7	69				It would be helpful to link this section back to the mitigation options presented in 7.5, discussing the policy links to each of the different options.	Accepted - the text now is more explicit about the differences in the different low carbon technologies.
20852	7	69	12			Technology policies are very important to solve global warming, independent of carbon placing. It shouldn't be placed as "complement" means.	Accepted - text revised
25891	7	69	12			This section is very weak. The Global Energy Assessment Chapter 24 contains much useful information (and reference to further material).	Taken into account - the section has been restructured according to the policy categories recommended by the Vigo accord. The general discussion of the design and need for technology policy is left to chapter 15.
20893	7	69	34	70	2	Not only advantages but also drawbacks as to feed-in tariff should be stated. There are several problems which should be solved in feed-in tariff system, such as increase in electricity bills or development of infrastructure by introducinig renewable energies rapidly.	Accepted - the paper of Frondel is cited.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26829	7	69	34	69	36	These lines in particular and the rest of the chapter in general does not include Auctions/Bidding/Tendering as a policy to deploy low carbon technologies/ renewabel energy technologies, despite their recent uptake in several countries. The SRREN included them as a quantity driven regulatory policy, Please see the suggested improvement below.	Accepted - text revised accordingly.
26830	7	69	34	69	37	Please modify the line "Price-based mechanisms … jurisdictions (REN21, 2012)" as "Price-based mechanisms (such as feed-in-tariffs, FITs), quantity-based systems (such as quotas or renewable portfolio standards, RPS and bidding/tendering) are the most common deployment policies in the power sector. In 2011, more than 65 countries and states used FIT policies; quotas or RPS were in place in 18 countries and in more than 53 other jurisdictions, and tendering was used in 36 countries (REN21, 2012; IRENA, forthcoming)". "Source: IRENA (forthcoming 2013), Assessment of Renewable Energy Tariff-based Support Mechanisms, policy brief"	Taken into account - text revised accordingly although the country listing was deleted due to space constraints.
26833	7	69	36	69	36	"In 2012" … The data from REN21, 2012 is from 2011. Therefore it should be "In 2011".	Taken into account - text revised accordingly although the country listing was deleted due to space constraints.
24658	7	69				Using 'project number' figures may be misleading as not all registered projects actually go ahead - some fail before they issue any CERs at all. Suggest that using the number of projects that have already issued units would result in a more accurate representation of the spread of technologies	Taken into account - comment is obsolete as Fig. 7.22 has been deleted.
31240	7	7				The lower left part of the figure seems to be showing electricity from various renewable energy sources as primary energy. The wind, biofuel, and solar radation could be considered as the primary energy, but I would consistently treat generated electricity as secondary energy. Thus, the schematic figures in the lower left should be shifted to the centre of the figure, in vertical alignment with the label "secondary energy". Both electricity from fossil fuel power plants and from renewable energy sources needs to go through transformers	Accepted - the figure is revised accordingly.
35386	7	7				The figure does not represent accurately the reality of MSW incinerators. First, the draw of where biomass is transported and burnt should also be receiving MSW from other sources, as waste is being used as fuel in these plants. Likewise, the draw of 'industry' stays out of the energy system, which ignores the fact that incinerators are included in the Renewable Energy regulations. The figure should be adapted to the reality of the energy systems. In Spain, for example, incinerator plants receive premiums for producing energy that is considered renewable. These premiums are an important economical input to incinerator industries and should be taken as a proof that this industry is part of the energy systems. Reference: Puig, I., Jofra, M. & Calaf, M., 2012. La puerta de atrás de la incineración de residuos.	Taken into account - waste used by MSW incinerators now is shown. The discussion of waste incinerators, however, is left to the industry chapter where they are discussed in detail.
35439	7	7				The figure does not represent accurately the reality of MSW incinerators. First, the draw of where biomass is transported and burnt should also be receiving MSW from other sources, as waste is being used as fuel in these plants. Likewise, the draw of 'industry' stays out of the energy system, which ignores the fact that incinerators are included in the Renewable Energy regulations. The figure should be adapted to the reality of the energy systems. In Spain, for example, incinerator plants receive premiums for producing energy that is considered renewable. These premiums are an important economical input to incinerator industries and should be taken as a proof that this industry is part of the energy systems. Reference: Puig, I., Jofra, M. & Calaf, M., 2012. La puerta de atrás de la incineración de residuos.	Taken into account - waste used by MSW incinerators now is shown. The discussion of waste incinerators, however, is left to the industry chapter where they are discussed in detail.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
31630	7	7		7		Although it is noted that the pathways are exemplary it is not clear that various important pathways both within and across the boundary have been omitted. For example biomass has a significant role in providing heat in buildings and within the energy system has a preparation step which may include drying, chipping, pelletisation etc. It should be emphasised that the overall picture is more complex than the figure. It is not clear on which side of the boundary lies the self generation of power by industry (for example from waste process heat).	Accepted - diagram and text revised.
23254	7	7				Symbols misleading - eg a road tanker for oil ignores shipping and pipelines; coal transport is by boat and road as well as rail; what are the symbols on bottom left corner? Which is hydro? Which geothermal? Or are they not there? Suggest redraw using text not symbols.	Accepted - diagram revised.
30072	7	7				figure not complete, the following connections have to be added: oil to power, gas to transport, power to gas, gas to power	Accepted -diagram revised
22599	7	7				Exchange the ancient historic table with a modern one - such one from the SRREN Figure 1.16 / Chapter 1 page 181 and add fossil and nculear to it	Taken into account - the style will be changed to a modern one; the sector labelling instead of the services stays in order to clarify the chapter boundaries.
26947	7	7				The figure does not represent accurately the reality of MSW incinerators. First, the draw of where biomass is transported and burnt should also be receiving MSW from other sources, as waste is being used as fuel in these plants. Likewise, the draw of 'industry' stays out of the energy system, which ignores the fact that incinerators are included in the Renewable Energy regulations. The figure should be adapted to the reality of the energy systems. In Spain, for example, incinerator plants receive premiums for producing energy that is considered renewable. These premiums are an important economical input to incinerator industries and should be taken as a proof that this industry is part of the energy systems. Reference: Puig, I., Jofra, M. & Calaf, M., 2012. La puerta de atrás de la incineración de residuos.	Taken into account - waste used by MSW incinerators now is shown. The discussion of waste incinerators, however, is left to the industry chapter where they are discussed in detail.
19867	7	7				Need to label the 4 icons at the lower left. I suggest these icons feed into "Electric Power Grid" instead of "Transmission Network", since many of them feed into the distribution as opposed to the transmission network. Similarly I suggest changing "Distribution Network" to "Electric Power Grid" since coal fired power stations feed into the transmission network. This diagram does not need to illustrate the difference between transmission and distributions networks, so its simpler to just say "electric power grid" for both.	Accepted - the figure is revised accordingly.
19869	7	7				Need to label the icon in the centre "Electric Power Station"	Accepted - the figure is revised accordingly.
26769	7	7	10			Minor correction to diagram needed. A significant proportion of renewable energy systems also feed into the distribution network, not just the transmission network (suggestion correction emailed to comments email address).	Accepted - the figure is revised accordingly.
36726	7	7	12	7	13	In figure caption, suggest replacing "exemplary" with "illustrative." The graphic shows usefully representative energy sources and pathways.	Accepted - the figure is revised accordingly.
36727	7	7	17	8	4	Suggest deleting the segment beginning with "Section 7.2 describes the global energy balance" and ending with "The last section addresses gaps in knowledge and data." Note the titles of subsequent sections are quite descriptive, and the desire to reduce the length of this chapter.	Rejected - the current text describes a roadmap and serves as a guidance for the readers which has been requested by many review comments in the past.
34162	7	7	2		6	Please refer here to Figure 1.3 which gives the overview of all the emissions.	Accepted - text revised.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
20444	7	7	2	7	2	See comment 13.	Noted - comment 13 cannot be located without additional information. However, every comment is answered where it is displayed.
32775	7	7	2	7	6	Reference for these figures.	Accepted - text revised.
36724	7	7	2	7	3	Citations are needed given uncertainties in LULUCF emissions and different choices for GWPs.	Accepted - text revised.
36723	7	7	2	70	60	Does "energy sector" as used here mean the entire sector or just the energy supply sector? This distinction, which is important to the reader, needs to be carefully reviewed throughout the chapter.	Accepted - text revised.
21117	7	7	24	7	24	Change 'the next section' to 'section 7.9'	Accepted - text changed accordingly.
23136	7	7	41	7	42	This can be read in a way that IPCC recommends the 450ppm pathways. So this is policy prescriptive; inappropriate.	Noted - comment seems to be misplaced. Line 41 is not existing on page 7.
36725	7	7	7	7	7	Does "report" refer to all of AR5 III - or just this chapter?	Taken into account - text revised to indicate that it is only used in chapter 7.
19868	7	7	9			Delete "consumer". This is not a consumer in the sense of you and me.	Accepted - text revised.
21773	7	7	8	16		The section begins by discussing the energy sector (e.g., line 2), also called the energy supply sector (e.g., line 4), with the energy sector (line 7) defined as the upstream, conversion and distribution parts of the energy system which in Figure 1 is then termed the energy system. Later (e.g., line 14), the section continues using the energy system (rather than the energy sector), and so on fairly interchangeably. The chapter is about the energy sector not the energy system. This should be made clear, and the terminology should be kept consistent throughout.	Taken - into account. The notation is used consistently throughout the chapter.
24282	7	7	8	8	7	It is suggested to add the description of energy consumption per capita and the energy consumption increaes per capita.	Noted. The space limitations do not allow it to discuss this. Normally, data for emissions per capita are provided for all sectors together. So this is a scope for Chapters 5 and 6. In the new figure 7.4 energy supply sector emissions per capita are provided.
31521	7	7	8	8	7	It is suggested to add the description of energy consumption per capita and the energy consumption increaes per capita.	Noted. The space limitations do not allow it to discuss this. Normally, data for emissions per capita are provided for all sectors together. So this is a scope for Chapters 5 and 6
19085	7	70				It seems that most CDM projects are electrical related!	Taken into account - comment is obsolete as Fig. 7.22 has been deleted.
20513	7	70	1		2	please update the references as there are newer studies available; e.g. Haas et al Energy 36 (2011), DIW dp 1176 (2011), Klessmann et al Renewable energy 57 (2013)	Accepted - the peer-reviewed paper Klessmann et al. now is taken into account. Haas et al. was already assessed by the SRREN. DIW is not peer-reviewed.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26814	7	70	12			Consider for inclusion- In addition, such a policy framework should address competing national priorities, market distortions, subsidies in favour of fossil fuels and lack of clear authority. "Financial Mechanisms and Investment Frameworks for Renewables in Developing Countries, IRENA-2012,pg. 31, "http://www.irena.org/DocumentDownloads/Publications/IRENA%20report%20-%20Financial%20Mechanisms%20for%20Developing%20Countries.pdf"	Taken into account - competing goals and subsidy removal now are discussed. The paper is cited in order to emphasize the specific needs of developing countries.
27073	7	70	13			Add "nuclear" in the bracket, so it reads "(e.g. most nuclear and RE)"	Rejected. This is no such bracket or discussion on page 70, line 13
25952	7	70	14	70	14	...energization agency…	Rejected. This sentence specifically refers to rural electrification
21160	7	70	17	70	21	Another issue to address is the need to educate people to get support for wind, solar and demand side response options	Rejected. No specific evidence or literature presented. Issues surrounding public perception of energy systems technologies are given in 7.9.4.
20514	7	70	19			IEA 2003b: this is a rather old reference. 10 years of technical progress should be reflected somewhere.	Rejected. No publication provided to support this change. The IEA 2003b reference is still an excellent resource.
30547	7	70	21	70	21	Interconnection should also be mentioned here. To talk about "back-up" power plants takes a very hydro-carbon centric view of power systems. A low carbon power system needs sufficient storage and interconnection in order to absolute disperced power sources	Accepted - a reference to 7.6.1 where these aspects are discussed is made.
21889	7	70	22	70	26	The market-based responses listed for addressing intermittent RE relate very clearly to smart grids - as noted on line 25 - but again, this entire relationship between market mechanisms and the infrastructure capabilities (from the end-use meter right up to the power plant via the networks, grids, switches, transformers and so on) has been almost entirely neglected in the chapter.	Taken into account - comment is obsolete as the underlying text has been deleted.
29657	7	70	3			The Global CCS Institute should absolutely not be cited in AR5, as it is an advocacy organization.	Taken into account - a peer-reviewed paper is used as a substitute.
26915	7	70	3	70	4	The Global CCS Institute should not be used as a citation, as it is an advocacy organization.	Taken into account - a peer-reviewed paper is used as a substitute.
29330	7	70	3	70	4	Here and throughout the chapter, a primary citation for CCS viability is from an advocacy organization, Global CCS Institute. There should be better, and more objective, studies on costs of CCS.	Taken into account - a peer-reviewed paper is used as a substitute.
34397	7	70	3	70	4	For a peer-reviewed paper on RDD&D support for CCS, please refer to von Stechow et al. (2011): Policy incentives for CCS technologies in Europe or Scott et al. (2012): Last chance for CCS.	Accepted - text updated.
20222	7	70	42	70	42	Note that the G20 statement is on phase-out of "inefficient fossil fuel subsidies" which would include both consumption and production subsidies.	Noted.
21890	7	70	42	70	47	The mention of vested interests right at the end makes salient the omission of political economic issues more broadly throughout the chapter. Perhaps this is appropriate for a technical review of mitigation options, but if so, it may be worth deleting it here. Otherwise, the reader's response is ... we need much more on this!	Taken into account.The discussion of policy implementation is discussed in detail in Chapter 15.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
26815	7	70	42			Consider for inclusion- They need to be supplemented by awareness creation, capacity building and information dissemination to the appropriate stakeholders. "IRENA (2012), IRENA Handbook on Renewable Energy Nationally Appropriate Mitigation Actions (NAMAs) for Policy Makers and Project Developers (Pg.18), http://www.irena.org/DocumentDownloads/Publications/Handbook_RE_NAMAs.pdf"	Taken into account - Revised text in 7.12 emphasizes the need for a stable regulatory environment including capacity building and information programmes. These elements are then discussed in depth in Chapter 15.
36901	7	70	43	70	43	Cite G20 Leaders Statements/Declarations in 2009 (Pittsburgh), 2010 (Toronto), 2011 (Cannes), and 2012 (Los Cabos).	Accepted. Citation included.
36900	7	70	6	70	21	How the system will work in the future is just as important as how it works now (l.11) By "fluctuating" do the authors mean "intermittent"? More common usage when applied to RE.	Accepted. "Fluctuating" changed to "intermittent" to reflect most common usage
23368	7	70	22	70	26	Specific: could add some literature on the effects of dynamic pricing (e.g. time-of-use pricing or peak-load pricing) on shift in peak demand, and benefits; some key literature includes:a) Faruqui, A., D. Harris, R. Hledik (2010). Unlocking the $53 billion savings from smart meters in the EU: How increasing the adoption of dynamic tariffs could make or break the EU's smart grid investment. Energy Policy 38. 6222-6231. b) Faruqui, A., J. Palmer, J. (2011): Dynamic pricing and its discontents. Regula-tion, Fall 2011. c) Faruqui, A. , J. R. Malko (1983). The Residential Demand for Electricity by Time-Of-Use: A Survey of Twelve Experiments with Peak Load Pricing, Energy 8(10), 781–795. d) Joskow, Paul L. 2012. Creating a Smarter U.S. Electricity Grid." Journal of Economic Perspectives, 26(1): 29–48 e) Borenstein, Severin. 2005. "The Long-Run Efficiency of Real-Time Electricity Pricing." Energy Journal 26(3): 93–116.	Accepted - some peer reviewed papers are included.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32495	7	706		707		The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Noted. Thank you very much for the additional references.
25736	7	71	1	71	4	This part should include "voluntary agreement" of an effective method to improve energy efficiency and reduce GHG emissions, as described in the section 15.5.7.4. There are successful examples of "voluntary target scheme" in the world. Each industry in Japan has voluntary target and the voluntary target scheme has played a big role, as described in (Yamaguchi, 2012, page35 and 154), (Manuel, 2010, page 6 and 13), and (Yamaguchi, 2010, abstract). In addition, there is also a successful example of "voluntary target scheme" in Netherlands, as shown in (Martijin, 2002, page162). These literatures are listed in the No22 line of this table.	Taken into account - a discussion of voluntary agreements as well as one of the mentioned references have been added.
36902	7	71	1	71	4	Recommend removing paragraph - inappropriately prescriptive formulation; misplaced and redundant content (overlaps Ch 13).	Taken into account - text is misplaced. It is moved to the FAQ 7.3 which is addressing barriers.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21891	7	71	11	71	17	It's odd to emphasise knowledge gaps on resources/reserves when these were argued not to be (geophysically) a limiting factor for mitigation. There are so many more salient knowledge gaps around costs, barriers, co-benefits, and developing country specifics that could be focused on instead.	Accepted - the discussion of fossil resources is reduced and other aspects are highlighted.
36905	7	71	11	71	13	The UN (UNECE (Ad Hoc Group on Harmonization of Resources Terminology), OECD, IEA, and others) have worked to standardize the definitions of reserves and resources. This effort should be at least mentioned. API also has definitions.	Taken into account - the comment is obsolete as the inconsistencies within the group of fossil fuels and their resources is not emphasized anymore. There is, however, no space to go into the details of resource accounting.
25953	7	71	18	71	18	...sites are important tasks to be done…	Accepted - context and site dependencies are mentioned now.
25626	7	71	2	71	4	See comment No.33.	Noted. Comment cannot be found.
36906	7	71	30	71	30	It is assumed that the authors intended "Efficacy of policies" rather than "efficiency of policies"?	Accepted - text revised.
19086	7	71	5	71	5	7.12.3 Enabling policies. I agree with most points in this section. But I would stress the need to assist rural people through training, provision of proper tools, expanding the market for bioenergy and providing modest loans	Taken into account - comment seems to be misplaced.
36903	7	71	6	71	31	The "gaps" paragraph seems to indicate that we know "nothing about nothing." That is not true. While some of the studies cited are subject to significant uncertainties, integrated assessment modeling exercises (some of which are cited) have done a reasonably good job of helping to define some of the tradeoffs between various energy system choices. This section would be more effective, if a few targeted suggestions were made to address the known and debilitating gaps.	Taken into account - the suggestions made now are more specific in order to identify research needs.
25471	7	71	7			replace the word "primary" to "primarily"	Taken into account - comment is obsolete. Text has been deleted.
33792	7	71	7			… in knowledge, primarily those …	Taken into account - comment is obsolete. Text has been deleted.
36904	7	71	8	71	8	"diversity of energy balances construction" - what does this mean? Diversity of sources? Why is "construction" used? This sentence needs to be rewritten, to convey what is meant.	Accepted - text revised.
20515	7	71				see comment No2.	Noted. Comment cannot be found.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32496	7	713				The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Noted. Thank you very much for the additional references.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
33878	7	72	0	111	0	There are very few references to geothermal papers and documents in their list of references. This pales in comparison to their treatment of other renewables and to fossil and nuclear energy which makes me even more skeptical that their coverage and analysis of geothermal energy has been comprehensively carried out.	Rejected - in addressing RE, the chapter relies heavily on the very recent IPCC SRREN report, which itself is balanced and provides many citations for each RE technology (also ensuring that there are fewer RE citations than fossil and nuclear citations). The space requirements for the chapter do not allow for comprehensive coverage of any single RE technology: the IPCC SRREN report therefore provides a good reference for more information on all of the RE technologies, and allowed us to de-emphasize comprehensive coverage of RE given space constraints. Geothermal is mentioned in most sections of the text that addresses renewable energy, and the issues of variable RE are mentioned in several sections. More broadly, where more coverage is given to land-based wind and solar and biomass it is because of issues specific to those technologies, as well as the fact that those technologies currently contribute more and/or are growing faster than other RE technologies such as geothermal, ocean, offshore wind, etc (additionally, biomass, solar and wind technologies are generally found to contribute more to climate mitigation in the long term in IAMs, as shown in the latter sections of the chapter). We have added one sentence on geothermal in section 7.5, noting recent developments in EGS (previously, the paragraph addressing recent technical developments in RE does not include an example for geothermal)

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20903	7	72	1	111	8	In chapter 7, there are 12 papers from "energy procedia" cited. All articles are published within the 9th and 10th International Conference on Greenhouse Gas Control Technologies proceedings, where no peer-review process has been undertaken (energy procedia 1 and 4). I don't see these articles as a sound scientific base.	Noted - It was and remains the judgment of the authors of Chapter 7 that these handful of papers published in Energy Procedia represent sound science that are worthy of citing here as they help to bolster points made in the text by referencing some of the most recent research on these topics. None of the citations to Energy Procedia papers are the sole citation to a key finding of Chapter 7. These papers help round out some of the finer points made in Chapter 7.
19087	7	72	5	72	5	7.13 Gaps in knowledge and data. In this chapter you state that the use of traditional energy is unsustainable. Yet you present no evidence. On the contrary the available evidence points to the fact that the annual growth of biomass, especially wood is 3 to 5 times demand. It is the clearing of land for agriculture that is the biggest cause of derorestation. Yet you persist in the myth that a major cause is the use of wood for bioenergy. See Openshaw (2011). Supply of woody biomass, especially in the tropics: is demand outstripping suppy? International Forestry review Vol. 13 4. Finally, in my opinion, the whole chapter is geared to promoting supplying electricity to the people without it using 'low carbon' sources namely wind, water and solar. these are 'high-tech' solutions that will mainly benefit the coutries who manufacture them. So people in LDC will not benefit very greatly. Of course, with electricity students may be able to study more and clinics etc can have refrigeration. But an over-riding need is to increase rural incomes and promoting biomass use is one of the solutions. I would like to see the expansion of biomass solutions and the reduction in pages of the energy forms.	Rejected - comment seems to be misplaced. Electricity plays an important role in the energy supply sector. Traditional use of biomass is to be discussed in the buildings chapter. Sustainable development issues are to be discussed in the framing chapters. The need to increase rural incomes is not a central aspects of the energy chapter. Nevertheless, micro energy financing schemes now are discussed. In addition, the connotation that traditional biomass is unstainable is avoided.

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32497	7	722		724		The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Accepted. The reference details has been revised.

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32498	7	733		734		The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Noted. Thank you very much for the additional references.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32499	7	758		759		The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Noted. Thank you very much for the additional references.

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32500	7	762				The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Accepted. The reference details has been revised.

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32501	7	766				The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Noted. Thank you very much for the additional references.

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32502	7	769				The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Noted. Thank you very much for the additional references.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
32503	7	772				The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Accepted. The reference details has been revised.

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32504	7	775				The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Noted. Thank you very much for the additional references.

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32505	7	777				The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Noted. Thank you very much for the additional references.

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32506	7	788				The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Accepted. The reference details has been revised.

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32507	7	793				The page numbers refer to the pages of the pdf document (and do not coincide with the page numbers as printed in the bottom right of the document. Life Cycle Assessment (LCA) is standardused by ISO with that name. Therefore, it should never be referred to as Life Cycle Analysis. Furthermore, once defined, it can be referred to simply as "LCA". Many important works of Brandão et al. (e.g. 2013) and Levasseur are missing, which are particular relevant to chapters 8 and 11. These are: -Brandão M, Levasseur A, Kirschbaum M, Cowie A, Weidema B, Jørgensen SV, Hauschild M, Chomkhamsri K, Pennington D (2013) Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. The International Journal of Life Cycle Assessment 18 (1) 230-240. DOI: 10.1007/s11367-012-0451-6. http://link.springer.com/article/10.1007%2Fs11367-012-0451-6 -Levasseur A, Lesage P, Margni M, Brandão M, Samson R (2012) Assessing temporary carbon sequestration and storage projects through land use, land-use change and forestry: comparison of dynamic life cycle assessment with ton-year approaches. Climatic Change. DOI: 10.1007/s10584-012-0473-x. http://www.springerlink.com/content/b3251u56v728m870/?MUD=MP13. -Levasseur A, Brandão M, Lesage P, Margni M, Pennington D, Clift R, Samson S (2012) Valuing temporary carbon storage. Nature Climate Change 2, 6–8. doi:10.1038/nclimate1335. http://www.nature.com/nclimate/journal/v2/n1/full/nclimate1335.html. -Brandão M, Mila i Canals L, Clift R (2011) Soil Organic Carbon changes in the cultivation of energy crops: implications for GHG balances and soil quality for use in LCA. Biomass & Bioenergy35 (6). 2323–2336. Special issue: Modelling Environmental, Economic and Social Aspects in the Assessment of Biofuels. http://www.sciencedirect.com/science/article/pii/S0961953409002402 -Brandão M, Clift R, Mila I Canals L, Basson L (2010) A Life-Cycle Approach to Characterising Environmental and Economic Impacts of Multifunctional Land-Use Systems: An Integrated Assessment in the UK. Sustainability 2(12): 3747-3776. Special issue: Life Cycle Sustainability Assessment. http://www.mdpi.com/2071-1050/2/12/3747/pdf -Mueller-Wenk R and Brandão M (2010) Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. The International Journal of Life Cycle Assessment 15(2) 172-182. http://www.springerlink.com/content/02628184t2q98051/fulltext.pdf -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. Springer. 125pp. -Brandão M (2012) Food, Feed, Fuel, Timber or Carbon Sink? Towards Sustainable Land Use: a consequential life cycle approach. PhD thesis. Centre for Environmental Strategy (Division of Civil, Chemical and Environmental Engineering), Faculty of Engineering and Physical Sciences, University of Surrey, UK. 246 pp. Appendices 541 pp. -Mulligan D, Edwards R, Marelli L, Scarlat N, Brandão M, Monforti-Ferrario F (2010) The effects of increased demand for biofuel feedstocks on the world agricultural markets and areas. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-16220-6. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16193/1/en24464_iluc%20workshop.pdf -Brandão M, Levasseur A (2011) Assessing temporary carbon storage in life cycle assessment and carbon footprinting: outcomes of an expert workshop. Joint Research Centre, European Commission, Ispra, Italy	Noted. Thank you very much for the additional references.
34164	7	8				The first senstence of the footnote makes no sense.	Accepted. Text was edited accordingly.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
29966	7	8		20		There are substantial overlaps between parts of Chapter 7 and Section 5.3 (Key drivers of global change). Chapter 7 could be shortened by removing text from Sections 7.2, 7.3 and 7.4 that is similar to text in Section 5.3.	Taken into account - The double digit structure was approved by the IPCC Bureau. Although general drivers were discussed in Chapter 5, specific drivers are discussed in sectorial chapters. This is important, bearing in mind that many readers do not go through the whole WGIII report, but read separate chapters. Nevertheless, the space devoted to 7.2 and 7.3 has been reduced considerably from 8 pages to 5 pages.
23256	7	8	13			Delete sentence :This chapter…..	Rejected - clarification is important, but text has been improved.
23257	7	8	14			Replace "this" by "provision of biomass"and add at end of sentence "…. Chapter 11 that covers land uses including agriculture and forests.	Accepted - text revised.
26792	7	8	18	8	23	Are liquid biofuels missing? Even if we can considered biodiesel as a refined oil products this is not the case for bioethanol.	Rejected. Liquid biofuels are shown in the column combustible renewables and waste in table 7.1.
34165	7	8	19		26	It is not clear why this paragraph spends so much space to the three other sectors (industry, transportation, building sector). The authors should evaluate whether this information should be skipped in the interest of page limitations.	Rejected. This paragraph illustrates what kind of energy is demanded by sectors and what the energy sector should provide.
32776	7	8	19	8	34	References for these figures, including base year.	Rejected. There is a reference to table 7.1, which is accompanied with source references. There is no need to provide those twice.
19053	7	8	19	8	20	Wood and other raw biomass are also converted to charcoal, liquid and gaseous fuels.	Rejected. That is true, but there are many transformations within the sector, many of which are considered later in the chapter. Here only the major ones are listed, as determined by space limit.
21119	7	8	21	8	26	Are consumption percentages with regards to total world energy consumption by fuel type?	Noted. As stated in the text, the shares are in global final use.
36728	7	8	21	8	21	Remove "and natural gas" - natural gas is a primary energy form, and the sentence already covers products of its conversion (e.g., to electricity, heat).	Rejected. Natural gas processing requires removal of liquids and other components and is to be provided in needed pressure. In this respect it is similar to enriched coal
23258	7	8	22			Change "Transportation" to "transport" throughout chapter to conform with Ch 8 terminology.	Accepted.
30073	7	8	24			52% of electricity use (Is this number correct???)	Noted. See table 7.1 for details.
36729	7	8	24	8	37	"76% of combustable..." and "37% efficiency..." should both be referenced. Is the "37% ...for fossil fuel power" only for conversion? Does it include T&D as implied by the sentence?	Accepted. The conversion factors are shown in table 7.1 and are now referenced.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
21774	7	8	27	8	30	Direct equivalent method of accounting for RE is mentioned in Figure 7.2 legend, but it would be helpful to include one sentence in main text here explaining that assumptions have to be made to make RE commensurate with fossil primary energy, and that direct equivalent method (used here) tends to under-represent RE compared to alternative methods (e.g., combustion equivalence).	Rejected. As footnote to table 7.1 says, it is described in the appendix, otherwise a short incomplete description will raise many unnecessary comments. In addition, this issue is valid for other chapters. Therefore, an appendix is the right place to address it.
23259	7	8	27			Add "nuclear," after "fuels,"	Rejected. The contribution of nuclear declined in the last decade.
34163	7	8	32	34		The interpretation of energy looses is a purely technical one. The economic interpretation must consider that the output energy carrier is of a much higher quality, which is reflected in hgiher prices paid, fo instance, for electricity instead of hard-coal. Also this figure heavily depends on the accounting principles of primary energy. In particular, if renewables are accouted according to the substitution principle the losses are higher than in the case of direct substitution. There is no a-priori criterion that governs the analysst to apply either the one or the other principle and therefore the quantitative assessment to a large degree depends on the choice of energy accounting. This assessment report should not be overburdeneed by these useless and endless discussions. Therefore, the paragrpah should be either rephrased or skipped. An issue that would make much more sense here, is to question the distribution losses (espec. for electricity) that are very different between countries. Here we have a mititgation potential that comes with increased technical and - probably - econoimc efficiency.	Rejected. Like in the case of input-output tables, this analysis and table 7.1 show the relationship between energy inputs and outputs. Like all economic activities provide value added, the energy sector provides energy quality added. It is important, like in case of input-output table to know what is the energy price for such higher quality. The conversion efficiency improvement is part of the chapter scope. Therefore, it is important to show the present status at the beginning of the chapter
21775	7	8	38	8	39	Explain final sentence more clearly about high multiplication effects of efficiency improvements / savings from end users. This is a good example of the energy demand lens through which the energy supply can be understood (see above).	Accepted. Text revised.
21118	7	8	5	8	16	Remove para and refer to table of contents	Rejected - the current text describes a roadmap and serves as a guidance for the readers which has been requested by many review comments in the past.
23255	7	8	9			Suggest: Transport fuel supply, use in vehicles, modal choice and local infrastructure are discussed in Chapter 8.	Accepted - text revised.
31631	7	8	5	8	6	It would be easier to grasp the detailed boundaries if the complete definition was provided in one place.	Accepted - paragraph shifted to Figure 1.
31632	7	8	31	8	32	This sentence is unclear, does it relate to growth of the sector overall or growth of energy use within the sector? It is not clear whether the increasing diversity has happened, is happening, will be happening. It is not clear how this link has been concluded as causal.	Rejected. This sentence clearly points at TPES - primary energy supplied to the whole global economy.
21776	7	8	39	8	39	First sentence of footnote 1 is not clear	Accepted. Text was edited accordingly.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
19701	7	82	7	82	9	The Edenhofer et al (2010) reference is wrongly cited. The correct full reference is: Edenhofer O., B Knopf, T. Barker, N Bauer, L Baumstark, P Criqui, A Held, M Isaac, M Jakob, E Jochem, A Kitous, S Kypreos, M Leimbach, B Magné, S Mima, W Schade, S Scrieciu, H Turton and D van Vuuren (2010) "The Economics of Low Stabilization: Model Comparison of Mitigation Strategies and Costs", The Energy Journal 31 (special issue 1 "The Economics of Low Stabilization"): 11-48	Accepted. The reference details has been revised.
20516	7	83	10		11	This is no EU Commission Publication, but the ninal report of a EU funded project. Please change.	Accepted. The reference details has been revised.
20517	7	83	4		6	This is a EU Commission publication and should be cited as: European Commission, 2012, COMMUNICATION FROM THE COMMISSION, Guidelines on certain State aid measures in the context of the greenhouse gas emission allowance trading scheme post-2012, (SWD(2012) 130 final), (SWD(2012) 131 final), (2012/C 158/04), Official Journal of the European Union, C154/4 – 22, 5.6.2012	Accepted. The reference details has been revised.
26383	7	89	1	89	2	SPECIFIC COMMENT. Check the correct link: "Hydrogen Production and Storage: R&D Priorities and Gaps", IEA, OECD, Paris, < http://www.iea.org/publications/freepublications/publication/hydrogen.pdf >.	Accepted. The link has been corrected.
34256	7	9				Remark: rather impressive, but surprisingly low impact of RES-E	Noted.
21120	7	9				This figure contains too much information and it is too small to be clearly read	Rejected. This figure presents information in a readable format and scale.
32995	7	9				Please update figure with regions that adhere to those agreed for use across the AR5 - defined in Annex II.	Accepted.
32996	7	9				The section often refers to regions that have not been agreed for use across the AR5. Please focus discussions on common regions, as defined in Annex II.	Rejected. The problem is: statistical systems do not use regions specified by the IPCC for reporting historical energy data. For example, there are no present source report data for OECD 90. In this chapter we really need detailed energy data. Therefore, we only can rely on existing statistical sources with their regional split
23260	7	9				What is the "etc" after solar, wind? Delete. Change "combustible and waste" (an IEA term) to "biomass and waste.	Accepted - diagram revised.
19870	7	9				Vertical axis should be labeled "Increment in Primary Energy (EJ)"	Accepted - diagram revised.
19871	7	9				At the lower right should "Asia" be "non-OECD Asia"? It would be good to have a listing of countries in an appendix showing how "OECD" overlaps with Europe, Asia etc.	Accepted. As to the country list, the reference to the IEA directs one to a complete country list for each region
32777	7	9	15	9	16	Specify which decade – it will avoid confusion for readers of this report in future years.	Accepted. Was specified.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
24284	7	9	15	9	16	"In the last decade, China alone was responsible for over half of the TPES increment making it now the leading energy-consuming nation." This description is somewhat misleading, China is not the final consumer of all the energy consumed.	Accepted. It was edited, while this is a weak argument. China is definitely the final user of the coal consumed. It does not consume all products manufactured using coal-fired power. But this is another story dealt with in Chapter 5. This paragraph just reflects the coal demand evolution, and no more than that.
31523	7	9	15	9	16	"In the last decade, China alone was responsible for over half of the TPES increment making it now the leading energy-consuming nation." This description is somewhat misleading, China is not the final consumer of all the energy consumed.	Accepted. It was edited. While this is a weak argument. China is definitely the final user of the coal consumed. It does not consume all products manufactured using coal-fired power. But this is another story dealt with in Chapter 5. This paragraph just reflects the coal demand evolution and no more than that.
32778	7	9	17	9	18	Specify which decade – it will avoid confusion for readers of this report in future years.	Accepted - text revised.
24285	7	9	19	9	21	"China was responsible for 82% of the global coal use increment in 2000-2010, followed by India; coal use in OECD Europe and Americas is declining. " This description is misleading, especially the data is so impressive. China is not the final consumer of all the coal consumed, and it's up to China's energy endowment.	Accepted. It was edited. While this is a weak argument. China is definitely the final user of the coal consumed. It does not consume all products manufactured using coal-fired power. But this is another story dealt with in Chapter 5. This paragraph just reflects the coal demand evolution and no more than that.
31524	7	9	19	9	21	"China was responsible for 82% of the global coal use increment in 2000-2010, followed by India; coal use in OECD Europe and Americas is declining. " This description is misleading, especially the data is so impressive. China is not the final consumer of all the coal consumed, and it's up to China's energy endowment.	Accepted. It was edited. While this is a weak argument. China is definitely the final user of the coal consumed. It does not consume all products manufactured using coal-fired power. But this is another story dealt with in Chapter 5. This paragraph just reflects the coal demand evolution and no more than that.
21122	7	9	21	9	21	The trend on coal consumption in Europe may be different now due to spark spreads. You should explicitly mention the cutting date for your analysis (e.g. Early 2013? End of 2012?)	Accepted. This new development was reflected. Nevertheless, the EU coal consumption in 2012 is still lower than in pre-crisis 2008.

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
23261	7	9	3			Caption suggestion: "Incremental change of the contribution of primary energy sources to global and regional demand over the periods 1990-2000 and 2000-2010". BUT NOTE: can't have 2000 in both. Is it 1990 - 1999 or 2001-2010?	Accepted diagram revised.
23262	7	9	4			Move sentence on "Modern biomass…" into text - not caption.	Rejected. The combustible and waste component now is replaced by biofuels and waste. Therefore, this clarification is in the right place.
36730	7	9	7	10	7	Text appears to mostly restate what is in Table 7.1 and Figure 7.2, including a lot of numbers. Having the table/figure should allow the authors to draw out only the key points in the text.	Rejected. Table 7.1 presents a static picture, while the text discusses trends as well. Figure 7.2. discusses only consumption increments without specifying production or trade, or rates of growth.
35264	7	9	8	9	11	This sentence is mainly about regional comparison, so it is inappropriate to single China out. It is suggested to delete “119% in China” and integrate data of China into “Non-OECD Asia”.	Noted. This is true. But if we speak about some key drivers it is important to go down to the country level, like with China (coal), or Japan and Germany (nuclear). Nevertheless the references to separate countries were substantially reduced in the final text.
21121	7	9	8	9	8	TPES? - include a list of acronyms at the beginning of the chapter to facilitate understanding	Noted. It is first spelled out on p. 8, line 29 and then repeated in table 7.1.
32997	7	9	8	9	9	It is unclear why China (a country) is singled out here amongst a discussion of TPES across regions. This could be politically problematic.	Noted. If we speak about some key drivers, it is important to go down to the country level, like with China and coal, or Japan or Germany and nuclear.
24283	7	9	17	9	27	The logic in this paragraph is very confusing. This paragraph mainly describes the rapid increase in Chins' coal production and consumption. However, the base year of comparison and the topic of this paragraph seems unclear.	Rejected. This paragraph illustrates what drives coal supply evolution. The time frame is quite clear: two decades are compared - 1991-2000 and 2001-2010. Coal demand, supply and trade are discussed. The title of this section offers to show the present situation and trends. What may be added, is a new trend for growing coal use by power sector in the EU

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31522	7	9	17	9	27	The logic in this paragraph is very confusing. This paragraph mainly describes the rapid increase in Chins' coal production and consumption. However, the base year of comparison and the topic of this paragraph seems unclear.	Rejected. This paragraph illustrates what drives coal supply evolution. The time frame is quite clear: two decades are compared - 1991-2000 and 2001-2010. Coal demand, supply and trade are discussed. The title of this section offers to show the present situation and trends. What may be added, is a new trend for growing coal use by power sector in the EU
24339	7	9	7	12	7	All the Section 7.2.2 should be removed, without causing any important loss in the quality and consistence of the Chapter 7.	Rejected. Regional energy supply developments are important drivers for understanding both static and evolving global energy picture
26828	7	93	35	93	35	Please recheck the names - they are incorrect	Accepted. Lehra was changed to Lehr.
20904	7	94	1	94	3	The name of the author is Lechtenböhmer rather than Leuchtenböhmer	Accepted. The spelling was corrected.
20448	7	96	27	96	27	To add: Möller, D, SONNE: solar-based man-made carbon cycle, and the carbon dioxide economy. Ambio 41, 413-419. See also comment 12.	Noted. Thank you very much for the additional references.
34505	7	ALL				I don't see the point of sections of this chapter. Not much different from annual report of International Energy Agency. However the biomass to biofuels transition pathways in the developing countries should be highlighted	Rejected - the chapter provides a recent update of mitigation options based on a detailed investigation of various stabilization pathways summarized in a database which contains more then 1200 greenhouse gas emissions scenarios. The IEA reports are based on one integrated assessment model and its specific input parameters and shortcomings. Biomass aspects related to developing countries now are discussed as part of the LDC box within 7.9.1.