

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
3403	7					A major report on CCS cost has been published by the European Technology Platform ZEP, incorporating robust cost data from many industrial participants in Europe and elsewhere.	Taken into account - the cost data provided there are taken into account.
3405	7					Very poor section. Superficial, simplistic, missinformative. Too many easywords ant too few numbers and solid references (emmission limits and legislation around the world for key contaminants?). Is the reference to SRREN correct when referring to a comprehensive assesment of nuclear energy health impacts?. Is the reference to CCS effects on human health (0-60% <sup>ijj</sup> ) reliable (Singh et al 2011) ?. Is it really that serious at global scale the lack of cooling water (see lines 11-19 in page 60). This is one of the lowest quality sections in this FOD.	Noted.
3406	7					As a lay citizen, I demand from the IPCC the highest possible rigour in handling this sensitive section. THIS IS POTENTIALLY VERY EMBARRASSING FOR THE IPCC PROCESS: numbers on casualties MUST BE SUPPORTED BY RELIABLE SOURCES, and conflictive numbers (if any) must be also reported in an IPCC report even if they do not fit with author's prejudices. I am not an expert on these issues, but I strongly feel this FOD is very far from the objective of a balanced view of the state of the art in section 7.9.3. IT SHOULD BE TOTALLY REWRITTEN AND THE AUTHORS FROM THIS POOR FIRST DRAFT SHOULD CONSIDER RESIGNATION IN VIEW OF THEIR SUPERFICIAL, UNREFERENCED FOD	Editorial comment. It would help us if the reviewer pointed what specifically appears unbalanced and in what way.
17210	7					It is not clear what the purpose of this table is. It contains a lot of numbers that are not fully put into perspective. Also, the table is difficult to understand and requires several explanations to make it understand. The LCAs may want to discuss whether the table could be skipped.	This table portraits the global energy picture in one table. This is the purpose of it.
17223	7					The y-axis scale is missing. This must be corrected.	Accepted. Figure has been corrected.
17216	7					The positive contribution of electricity per GDP is surprising. The authors are requested to check this.	Taken into account – Please note that the figure has been replaced and the analysis has been updated. The original figure was easy to misunderstand, and resulting confusion may have been the cause of this comment.
17217	7					What is the data source for the growth of GDP? Is this IMF, Worldbank, or something else?	This is IEA data. See note to the figure 7.4
17220	7					The figure is not from the peer-reviewed literature. The CLAs are requested to use peer reviewed literature for such a figure.	Taken into account: GEA is peer reviewed literature - the in the figure data are GEA but the concept of presentation was 'borrowed' from Farrel. Carbon contents calculated from GEA energy resource data using IPCC intensities.
6417	7					It would help to define TPES in the table, or to spell it all out where it is bold in the third row	Accepted. It has been spelled out.
6416	7					This figure seems odd. The top is difficult to interpret, given how the x axis is partitioned and not in order.	Design of the figure 7.1 was improved

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6430	7					The "baselines" are confusing. Does it represent business as usual? If not, it seems as though BAU should be added. If so, some reference to BAU as a baseline would be helpful.	The baseline refers to the fact that there is no climate policy assumed in the scenario. There might be other aspects in the scenario, however, which are not BAU. We should leave the figure as it is. -> non intervention scenarios...
16113	7					This section as a whole is not balanced. There is presently no CCS industrial scale installation on a thermal plant, the main presumed market, as justly mentioned in lines 7-8 page 31. The paragraph should take more space to explain why, if the technology is as available as mentioned earlier in the section. Instead, it goes around a myriad of references as to please everyone, but gives no credible roadmap for cost-cutting in the short and medium-term. is given. Then why allocate so much (2 pages) for a technology that promises less in the medium term than, say, wave power or thermal recovery with new cycles?	Rejected. No scientific evidence or body of peer reviewed literature is offered in support of this observation. The totality of what is written about CCS in all parts of Chapter 7 seems balanced. But because it is broken up and scattered it lead to many comments like this. The new version has been improved accordingly.
15540	7					This chapter could be shortened by having less text describing data already presented in graphs and tables e.g. material on p 13 describing evidence presented in Table 7.1. Some of the material describing developments in energy use and supply is not particularly relevant for emissions and climate change.	Accepted - text revised.
2352	7					Reference to be assessed on transaction cost "Updated capital cost estimates for Electricity generation plants, EIA, Nov 2010" (sorry, dont have report and page number)	Noted
9260	7					Excellent way of presenting the data!	Noted
5737	7					Probably this table considers just fuel used in agriculture/forestry/fisheries and this is why the energy consumption of agriculture looks so low. Including indirect energy and electricity uses would change the scenario a lot ( <a href="http://www.fao.org/docrep/014/i2454e/i2454e00.pdf">http://www.fao.org/docrep/014/i2454e/i2454e00.pdf</a> )	Taken into account. It is not a scenario. It covers only direct consumption.

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5743	7					I cannot agree with the definition of modern/traditional bioenergy contained in the figure as too simplistic. Using fuel wood in an open fireplace is not 'modern' for example. Please use and include where appropriate the definition developed by GBEP (see the glossary of the GBEP sustainability indicators report: <a href="http://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/Indicators/The_GBEP_Sustainability_Indicators_for_Bioenergy_FINAL.pdf">http://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/Indicators/The_GBEP_Sustainability_Indicators_for_Bioenergy_FINAL.pdf</a> )	GBEP does not define traditional biomass. They define modern or traditional bioenergy services. "Modern bioenergy services are defined as modern energy services relying on biomass as their primary energy source. Modern bioenergy services include electricity delivered to the final user through a grid from biomass power plants; district heating; district cooling; improved cookstoves (including such stoves used for heating) at the household and business level; stand-alone or grid-connected generation systems for household or businesses; domestic and industrial biomass heating systems; domestic and industrial biomass cooling systems, biomass-powered machinery for agricultural activities or businesses; biofuel-powered tractors and other vehicles, grinding and milling machinery. Modern bioenergy services do not include biomass used for cooking or heating purposes in open stoves or fires with no chimney or hood or any other energy systems that release flue gases indoors or release high concentrations of air pollutants, irrespective of the feedstock or biofuel employed. Modern bioenergy is used to describe energy, for example when we need to quantify it or use the term in an abstract sense, which delivers modern bioenergy service"
13300	7					For the UK, the most comprehensive MAC curve analysis was undertaken by the Committee on Climate Change in our report 'Building a low-carbon economy' in 2008. This report recommended the UK's 2050 target and 'carbon budgets' from 2008-22, which were then set in law under the Climate Change Act. It is available from <a href="http://www.theccc.org.uk/reports/building-a-low-carbon-economy">http://www.theccc.org.uk/reports/building-a-low-carbon-economy</a>	Taken into account - table 7.5. was deleted due to space constraints. Comment is obsolete.

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11873	7					Can you expand on the "carbon neutral is not climate neutral" points? There is a long list of citations, but there is no explanation of what those studies said - include a list of some of those reasons. Similarly, the highlighting of bottom up analyses is equally vague - what are some of the relevant climate effects that are being considered? Also (and this is linked to the Forcings of Biogenic CO2 issue) it might be a good idea to (1) include a citation to PAS2050 which addresses/discusses some of these questions/points at least from an accounting perspective, and (2) there is a lot of literature on temporary carbon storage in biomass/forests that started in the 90s but only Cherubini's forestry work is cited (this is not to dispute the high quality of the cited work, but it seems important to reference the is a larger body of literature on the topic since other research has addressed different nuances of the issue).	Rejected - comment seems to be misplaced. Please clarify to which part of the text your comment actually refers. 7.14 is about frequently asked questions.
11854	7					This figure needs axis labels - in its current form it is impossible to interpret	Accepted. Figure has been corrected.
11857	7					This figure is not clear (both literally and figuratively). This figure needs improved explanation if it is to stay in.	Taken into account - figure has been deleted.
11849	7					This figure is difficult to interpret. While it is noted that the data will be updated, I believe the approach to labeling and discussing the figure must be changed as well. Perhaps have one pie chart with "energy related" and "non energy-related" emissions, then have break-outs of the composition of those section for each? Also, reporting CO2e emissions clearly requires that the GWP time horizon be stated (assuming 100-year, but should be explicitly stated), as well as the GWP publication year (assuming that the GWPs reported in WG4's AR5 contribution will be used, but still worth reporting).	Taken into account. The section has been deleted.
11871	7					This figure requires a legend, the reader cannot interpret the data presented, what does the grey, red and blue mean?	The figure in question has been removed. New figures have been introduced.
11858	7					This section isn't exactly duplicative, but transmission (as well as resource availability) are also discussed with some overlap in concepts in subsections of 7.4. Can these sections be eliminated/combined with those in 7.4? This might be an opportunity to reduce length.	Rejected - the discussion in 7.4 only refers to a more extended here.
9238	7					Please update latest number (year 2010) if possible.	Accepted. Was done
9241	7					Please refer latest edition of the Red Book (2012) if possible.	Taken into account. The section has been deleted.
6803	7					Overall, I found this chapter lacking in terms of describing the various carbon-free energy alternatives (with the exception of details provided on nuclear technologies). Solar energy is properly identified as the largest resource, but there is no description of the various PV and CSP technologies and their pros and cons. For example, capacity factors as well as capacity values can vary greatly. Also lacking is any description of the current R&D opportunities and targets. Finally, repeated studies have shown that energy efficiency has the largest carbon reduction potential and negative costs. Yet efficiency is only briefly mentioned in the context of transmission.	Rejected - renewable energies have been discussed in detail in the recent IPCC special report on renewable energies (SRREN). Space constraints do not allow to repeat all information on renewable energies given there in the AR5. Energy efficiency is not discussed in Chapter 7 as it is part of the end-use demand chapters (8-10).
6801	7					For nuclear, the cost range is too narrow and the average cost is too low compared to some studies on the costs of new plants. Later on page 50, line 20, a cost range of 42 \$/MWh to 137 \$/MWh is given. Also, later comments properly point out that costs will likely escalate in the post-Fukushima environment.	Taken into account - the cost data have been updated.

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6802	7					The various costs in the table are not comparable because they do not account for the varying subsidies given to each. And, of course, the costs associated with environmental externalities are not included. This report should reference the U.S. National Academy study on the true costs of energy.	Rejected - BNEF's LCOE analysis reflects the generation cost without direct subsidies, such as feed-in tariffs or green certificates. This is mentioned in the text. Space constraints do not allow for a detailed discussion of the externalities. That fact that these are not considered now is included.
6231	7					a distinction must be made between capacity (GW) & energy (GWh) as the technologies have significantly different utilization capacities	Taken into account. The section has been deleted.
6225	7					This graph does not add any useful information	Rejected. The claim for an unbalanced treatment would need to be better substantiated. Here, additional material demand is discussed. There is no space for a more extensive discussion
6246	7					Indications for the amount of the y axis?	Accepted. Figure has been corrected.
6232	7					a 10% IRR is not commercial and underestimates real costs, 15% would be more appropriate	Rejected - LCOE are highly dependent on various sensitiveness. In order to establish a common baseline for comparison 10% has been used. According to <a href="http://www.oxera.com/Publications/Reports/2011/Discount-rates-for-low-carbon-and-renewable-genera.aspx">http://www.oxera.com/Publications/Reports/2011/Discount-rates-for-low-carbon-and-renewable-genera.aspx</a> 10% is close to the mean value suggested there for nuclear power plants (11%).
6233	7					diagram does not add any message	Editorial. The figure presents a lot of information that is not repeated in the text.
6234	7					message lost in information overload	Accepted: We have extensively rewritten this section to try to sharpen our messages.
6235	7					this graph adds nothing other than confusion	Taken into account - comment is obsolete. Figure has been deleted.
6228	7					The top graph is illegible	Taken into account. The section has been deleted.
16835	7					Nice chart -- would be greatly improved if it also included Natural Gas/CCS, IGCC/CCS and Oxyfuel/CCS as these are all technologies that models indicate may be important parts of a mitigation set.	Accepted - CCS costs are shown in chart.

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4318	7					<p>This table measures recent growth in renewable energy only in installed MW of capacity, rather than energy generated (MWh). This is seriously misleading. Firstly, wind farms generate more than about 85% of installed capacity for a very short time—probably in the region of 2%. It would be fair to say that the effective maximum capacity of a wind farm is about 80% of the installed capacity. So to compare the installed capacity of renewable energy with conventional power stations that will deliver 100% of installed capacity when needed, is seriously misleading. Secondly, the capacity factor of renewable energy technologies (apart from hydropower) is very low indeed. Few windfarms generate a capacity factor of more than 30%, and most are in the region of 20 to 25%. A well sited solar farm in a tropical area has a capacity factor of about 22% while those in Germany have a capacity factor of 9.5%. ( <a href="http://theenergycollective.com/willem-post/46142/impact-pv-solar-feed-tariffs-germany">http://theenergycollective.com/willem-post/46142/impact-pv-solar-feed-tariffs-germany</a>) With capacity factors like this, roughly 9,000 MW of solar power is required to produce the same amount of energy as a 1000 MW nuclear power station. But, because of solar cells will not be producing anything during peak demand times in winter, a 1000 MW backup plant would also be needed. According to <a href="http://www.pv-tech.org/news/it_cost_3.6_million_per_mw_to_purchase_solar_power_projects_in_2011">http://www.pv-tech.org/news/it_cost_3.6_million_per_mw_to_purchase_solar_power_projects_in_2011</a> solar power plants cost €3.6 million per megawatt. So we can compare the cost of a €5 billion nuclear power plant (approximately US\$6.6 billion) with €32 billion for 9000 MW of solar power plus €2 billion for the backup plant. So, on the equivalent basis, solar power cost is roughly 6.8 times higher. And that is without any allowance for the additional transmission. Even if the nuclear power cost was double the figure given, the difference is huge. I believe that it should be pointed out that the low capacity factor of solar and wind power brings additional costs that need to be taken into account</p>	<p>Table 7.4 is not on this page. It is on page 33. If table 7.1 is meant it speaks only on billion kWh</p>
10800	7					<p>The chapter is too long, improvement shall be made to enhance the coherence and focus. State clearly the pupuse of each section, scopes, gaps, and limitation in the information, data and conclusions presented. The chapter falls short of presenting potential risks (long-term) of nuclear accidents (man-made or caused by natural forces). In addition, it's important to compile/analyze/present data on the costs of renewables in consistent manner, in comparisons with tranditional energy sources. The relevant sections should include more data of RE costs (from material, transport, manufacturing, utilization, integration) as well as quantifiableof benefits. In general, every sections shall be shortened and shall try to avoid ambiguous statements. If in doubt or opinionated, authors shall point out what is the knowledge gap as of today and proactively acknowledge reseach areas to be expected and recommended in the future. Getting rid of ambiguous statements/paragraphs shall help truncating the chapter within 60 pages.</p>	<p>Accepted - text revised as far as space constraints allowed this.</p>
17283	7					<p>This figure is quite nice. However, I am missing Final Energy in the analysis. In my view, FE is more meaningful than TPES, because less ambiguities exist in its definition and accounting. I would suggest adding FE/GDP and PE/FE as indicators in the decomposition.</p>	<p>Thank you. Adding final energy to it will overloaded it and make it harder to read. For chapter 7 is important how much energy the energy sector has to deliver overall. New fig. 7.2 has FEC/GDP ratio</p>

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17391	7					General comments. The chapter provides a very clear account of the major issues, and particular, the major changes since the last report. The writing team exhibit an excellent appreciation of the significance of the many relevant events since the last report, and exhibit sensible, pragmatic and informed assessments of their likely impact. Of particular importance here is the greater growth in GHG, which exceeded that of GDP per capita in the latest period (attributable largely to growth in economies and population) with a shift towards coal in generation (mainly reflecting China's and India's demands). There is a wealth of detail and many carefully balanced judgements are reported together with an indication of the extent of agreement and the quality of the relevant evidence. The overall impression is of a carefully considered, well-balanced report, which draws on the best available evidence.	Noted. Thank you.
17392	7					In terms of detail a number of things occurred to me, though unfortunately I did not have time to go through the text in detail. Firstly, I think the draft status does show a little and the English needs a little tidying up throughout (though this is a minor issue – and I fear one that if it was fully met could only increase the length of the chapter). Secondly, I felt that there was a fair amount of repetition (perhaps because different sections were written by different individuals), which while useful for emphasis, might be pruned given the pressure on space. Thirdly, while the discussion of the carbon price was very sensible, I wondered if its fundamental importance gets a bit lost in the detail. Of course it is not the only policy, but frankly without the establishment of a credible long-term price of carbon (and I think that is going to require taxes – though these need to be “balanced budget” to be acceptable, and revenues targeted for “green” purposes - it is difficult to see how all the other policies can work. Fourthly, the authors quite rightly emphasise the externalities associated with RD&D and the importance for low carbon technologies, but it would be useful to have some indication of appropriate scale of intervention. Fifthly, while issues of policy coordination are raised and discussed I fear the problem is rather bigger than explicitly acknowledged here: and without the political will to do so it is difficult to see how this problem is going to be resolved. We have numerous overlapping policies (even in single countries) generating responses of unknown complexity, and numerous countervailing effects the net outcome of which is unclear. (The consequences of trading schemes for renewable generation technologies included in the traded sector is now a well-understood example, but only one example of the importance of multi-level governance here.) Sixthly, the discussion of the co-benefits was useful, and indeed it may be critical politically yet it seemed to lack a coherent unifying framework (and quantification) that might enhance the important main message here (perhaps “welfare” is problematic?). Finally, in terms of gaps, the absence of regularly updated input-output (and ideally social accounting matrix data) limit both our descriptive and modelling abilities. On the latter our understanding of the interdependencies of the energy-economy-environment subsystems remains rudimentary yet is crucial to a full understanding of, and ability to evaluation, energy and climate change policies.	Improved in SOD. For carbon prices, see 7.12.
17393	7					Peter McGregor, 14 September 2012.	Noted
17812	7					1. Household energy insecurity in Europe is a combination of a problem of “supply” – where some households generally lack access to network energy for cooking or space-heating or temporarily lack access to electricity for hours or days at a time – and a problem of “demand” – where households cannot afford sufficient amounts of energy, energy-efficient housing or heating equipment.	That is more the subject of chapter 9. It could only be briefly mentioned in section 7.9.1.2
17813	7					2. The following policy priorities to improve household energy security emerge for the WHO European region:	That is more the subject of chapter 9. It could only be briefly mentioned in section 7.9.1.2

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17814	7					§ Households in eastern Europe and Central Asia that currently cook with biomass fuels or coal should gain access to cleaner fuels and/or cleaner-burning and more fuel-efficient cookstoves.	That is more the subject of chapter 9. It could only be briefly mentioned in section 7.9.1.2
17815	7					§ Households that cannot afford to maintain health-protective temperatures during the winter months should be supported through a combination of appropriate social support, tariff measures and strategies to upgrade old housing stock to improve energy efficiency.	That is more the subject of chapter 9. It could only be briefly mentioned in section 7.9.1.2
17816	7					§ Households across the WHO European region that are at particular risk of experiencing heat distress – through their building design or the characteristics of their inhabitants – should be encouraged to improve thermal insulation and, where appropriate, to install air conditioning or electric fans.	That is more the subject of chapter 9.
17817	7					3. Measures to increase household energy efficiency can bring substantial savings in CO2 emissions and thereby contribute to climate change mitigation (the building stock having the highest share of negative and low-cost greenhouse gas reduction potential among all sectors).	That is more the subject of chapter 9.
17818	7					Bettina, if I remember correctly EURO advised that Eastern in this context need to be written with a small ,e' – to be corrected in the whole text.	Editorial
17819	7					I think this statement refers to Ref 88.	What statement?
17820	7					1. Household energy insecurity in Europe is a combination of a problem of “supply” – where some households generally lack access to network energy for cooking or space-heating or temporarily lack access to electricity for hours or days at a time – and a problem of “demand” – where households cannot afford sufficient amounts of energy, energy-efficient housing or heating equipment.	Noted. That is more the subject of chapter 9.
17821	7					2. The following policy priorities to improve household energy security emerge for the WHO European region:	Noted. That is more the subject of chapter 9.
17822	7					§ Households in eastern Europe and Central Asia that currently cook with biomass fuels or coal should gain access to cleaner fuels and/or cleaner-burning and more fuel-efficient cookstoves.	Noted. That is more the subject of chapter 9.
17823	7					§ Households that cannot afford to maintain health-protective temperatures during the winter months should be supported through a combination of appropriate social support, tariff measures and strategies to upgrade old housing stock to improve energy efficiency.	Noted. That is more the subject of chapter 9.
17824	7					§ Households across the WHO European region that are at particular risk of experiencing heat distress – through their building design or the characteristics of their inhabitants – should be encouraged to improve thermal insulation and, where appropriate, to install air conditioning or electric fans.	Noted. That is more the subject of chapter 9.
17825	7					3. Measures to increase household energy efficiency can bring substantial savings in CO2 emissions and thereby contribute to climate change mitigation (the building stock having the highest share of negative and low-cost greenhouse gas reduction potential among all sectors).	Noted. That is more the subject of chapter 9.
17826	7					Bettina, if I remember correctly EURO advised that Eastern in this context need to be written with a small ,e' – to be corrected in the whole text.	Editorial
17827	7					I think this statement refers to Ref 88.	What statement?

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17829	7					References for page 59	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17830	7					Abbey DE, Lebowitz MD, Mills PK, Petersen FF, Lawrence Beeson W, & Burchette RJ 1995. "Long-term ambient concentrations of particulates and oxidants and development of chronic disease in a cohort of nonsmoking California residents". Inhalation Toxicology, vol. 7, 19-34.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17831	7					Abbey DE, N Nishino, WF McDonnell, RJ Burchette, SF Knutsen, WL Beeson and JX Yang 1999. "Long-term inhalable particles and other air pollutants related to mortality in nonsmokers". Am. J. Respir. Crit. Care Med., vol 159, 373-382.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17832	7					Abt 2000. "The Particulate-Related Health Benefits of Reducing Power Plant Emissions." October 2000. Prepared for EPA by Abt Associates Inc., 4800 Montgomery Lane, Bethesda, MD 20814-5341.	Rejected. We prefer to rely on peer reviewed literature where possible.
17833	7					Abt 2004. "Power Plant Emissions: Particulate Matter-Related Health Damages and the Benefits of Alternative Emission Reduction Scenarios". Prepared for EPA by Abt Associates Inc. 4800 Montgomery Lane. Bethesda, MD 20814-5341.	Rejected. We prefer to rely on peer reviewed literature where possible.
17834	7					Anderson HR, Atkinson RW, Peacock JL, Marston L, Konstantinou K. 2004. "Meta-analysis of time-series studies and panel studies of particulate matter (PM) and ozone (O3)". Report of a WHO task group. World Health Organization. ( <a href="http://www.euro.who.int/document/e82792.pdf">http://www.euro.who.int/document/e82792.pdf</a> ; accessed November 2004).	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17835	7					Bobak M, Leon DA. 1999. "The effect of air pollution on infant mortality appears specific for respiratory causes in the postneonatal period". Epidemiology 10(6), 666-670.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17836	7					CAFE 2005. "Damages per tonne emission of PM2.5, NH3, SO2, NOx and VOCs from each EU25 Member State (excluding Cyprus) and surrounding seas". Report for European Commission DG Environment, by AEA Technology, Didcot, Oxon, OX11 0QJ, United Kingdom. Authors: Mike Holland (EMRC), Steve Pye, Paul Watkiss (AEA Technology), Bert Droste-Franke, Peter Bickel (IER). March 2005.	Rejected. We prefer to rely on peer reviewed literature where possible.
17837	7					CEA 2006. "Catalog of Preference Scores". Cost Effectiveness Analysis (CEA) Registry of Tufts-New England Medical Center. Downloaded 2 July 2006 from <a href="http://www.tufts-nemc.org/cearegistry/index.html">http://www.tufts-nemc.org/cearegistry/index.html</a>	Rejected. We prefer to rely on peer reviewed literature where possible.
17838	7					Chen H, Goldberg MS, Villeneuve PJ. 2008. "A Systematic Review of the Relation between Long-term Exposure to Ambient Air Pollution and Chronic Diseases". Reviews On Environmental Health, Vol. 23 (4), 243-297.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17839	7					Cohen AJ, Anderson HR, Ostro B, Pandey KD, Krzyzanowski M, K nзли N, Gutschmidt K, Pope CA, Romieu I, Samet JM, Kirk R. Smith KR. 2005. "Urban air pollution", Chapter 17 of Global Burden of Disease World Health Organization, Geneva ü	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17840	7					Crawford M & R Wilson 1996. "Low-dose linearity: the rule or the exception?", Human and Ecological Risk Assessment, vol.2, 305-330.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17841	7					Daniels MJ, Dominici F, Samet JM & Zeger SL. 2000. "Estimating particulate matter-mortality dose-response curves and threshold levels: an analysis of daily time-series for the 20 largest US cities." Am J Epidemiol, 152(5):397-406. See also Comment in: Am J Epidemiol., 152(5):407-12 .	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17842	7					Daniels MJ, Dominici F, Samet JM & Zeger SL. 2004. National Morbidity, Mortality, and Air Pollution Study. Health Effects Institute report 94, Part III: Concentration-Response Curves and Thresholds for the 20 Largest US Cities.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17843	7					EC 2001. Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants.	Rejected. We prefer to rely on peer reviewed literature where possible.
17844	7					EC 2007. "Sustainable power generation from fossil fuels". Commission Communication of 10 January 2007. Downloaded 3 May 2012 from <a href="http://europa.eu/legislation_summaries/energy/european_energy_policy/l27068_en.htm">http://europa.eu/legislation_summaries/energy/european_energy_policy/l27068_en.htm</a>	Rejected. We prefer to rely on peer reviewed literature where possible.
17845	7					EEA 2011. "Revealing the costs of air pollution from industrial facilities in Europe". EEA Technical report No 15/2011. European Environment Agency, Copenhagen.	Rejected. We prefer to rely on peer reviewed literature where possible.
17846	7					Ellenbogen JM, Grace S, Heiger-Bernays WJ, Manwell JF, Mills DA, Sullivan KA, Weisskopf MG. 2012. "Wind Turbine Health Impact Study: Report of Independent Expert Panel". January 2012. Prepared for: Massachusetts Department of Environmental Protection, Massachusetts Department of Public Health	Rejected. We prefer to rely on peer reviewed literature where possible.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17847	7					Elliott P, Shaddick G, Wakefield JC, de Hoogh C, Briggs DJ. 2007. "Long-term associations of outdoor air pollution with mortality in Great Britain." Thorax 2007 (0), 1–8.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17848	7					EURELECTRIC 2011. Power Statistics & Trends 2011 – synopsis. The Union of the Electricity Industry, Brussels. Downloaded 3 May 2012 from <a href="http://www.eurelectric.org/PowerStats2011/PowerStats2011.asp">http://www.eurelectric.org/PowerStats2011/PowerStats2011.asp</a>	Rejected. We prefer to rely on peer reviewed literature where possible.
17849	7					ExternE 1995. ExternE: Externalities of Energy. ISBN 92-827-5210-0. Vol.5: Nuclear (EUR 16524). Published by European Commission, Directorate-General XII, Science Research and Development. Office for Official Publications of the European Communities, L-2920 Luxembourg.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17850	7					ExternE 2005. ExternE – Externalities Of Energy: Methodology 2005 Update. Available at <a href="http://www.externe.info">http://www.externe.info</a>	Rejected. We prefer to rely on peer reviewed literature where possible.
17851	7					Gauderman JM, Avol E, Gilliland F, Vora H, Thomas D, Berhane K, McConnell R, Kuenzli N, Lurmann F, Rappaport E, Margolis H, Bates D and Peters J. 2004. "The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age". N Engl J Med, 351:1057-67.	Rejected. We prefer to rely on peer reviewed literature where possible.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17852	7					Hedley AJ, Chit-Ming Wong, Thuan Quoc Thach, Stefan Ma, Tai-Hing Lam, Hugh Ross Anderson. 2002. "Cardiorespiratory and all-cause mortality after restrictions on sulphur content of fuel in Hong Kong: an intervention study", Lancet, vol.360, November 23.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17853	7					HEI 2001. "Airborne particles and health: HEI epidemiologic evidence". HEI Perspectives, June 2001. Health Effects Institute, Charlestown Navy Yard, 120 Second Avenue, Boston, MA 02129-4533. Available at <a href="http://www.healtheffects.org/">http://www.healtheffects.org/</a>	Rejected. We prefer to rely on peer reviewed literature where possible.
17854	7					Holland M, Hunt A, Hurley F, Navrud S, Watkiss P. 2005. Methodology for the Cost-Benefit Analysis for CAFE: Volume 1: Overview of Methodology. Didcot. UK: AEA Technology Environment. Available: <a href="http://europa.eu.int/comm/environment/air/cape/pdf/cba_methodology_vol1.pdf">http://europa.eu.int/comm/environment/air/cape/pdf/cba_methodology_vol1.pdf</a>	Rejected. We prefer to rely on peer reviewed literature where possible.
17855	7					Hurley F, Miller B, Torfs R, Rabl A. 2005. "A set of concentration-response functions". Deliverable 3.7 - RS1b/WP3 of NEEDS project, available at <a href="http://www.needs-project.org/RS1b/NEEDS_RS1b_D3.7.pdf">http://www.needs-project.org/RS1b/NEEDS_RS1b_D3.7.pdf</a>	Rejected. We prefer to rely on peer reviewed literature where possible.
17856	7					ICRP 1991. 1990 Recommendations of the International Commission on Radiological Protection. Publication ICRP 60.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17857	7					ICRP 2007. The 2007 Recommendations of the International Commission on Radiological Protection. ICPR Publication 103. Elsevier.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17858	7					IEA 2008. World Energy Outlook 2008. International Energy Agency, 9 rue de la Fédération, 75739 Paris Cedex 15, France.	Rejected. Too little specific to our issue
17859	7					Katsouyanni K, Touloumi G, Spix C, Schwartz J, Balducci F, Medina S, Rossi G, Wojtyniak B, Sunyer J, Bacharova L, Schouten JP, Ponka A, Anderson HR. 1997. "Short-term effects of ambient sulphur dioxide and particulate matter on mortality in 12 European cities: Results from time series data from the APHEA project." British Med. J 314:1658–1663.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17860	7					Laden F, LM Neas, DW Dockery, & J Schwartz 2000. "Association of Fine Particulate Matter from Different Sources with Daily Mortality in Six U.S. Cities". Environmental Health Perspectives - New Series, volume 108 - issue 10, Pages: 941 - 948 (2000).	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17861	7					Leksell L and A Rabl. 2001. "Air Pollution and Mortality: Quantification and Valuation of Years of Life Lost". Risk Analysis, vol.21 (5), in press.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17862	7					Levy JI, Hammitt, JK, Spengler JD. 2000. "Estimating the mortality impacts of particulate matter: What can be learned from between-study variability?" Environ Health Perspect 108(2):109–117.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17863	7					Lippmann M, Ito K, HwangJ-S, Maciejczyk P, Chen L-C. 2006. Cardiovascular Effects of Nickel in Ambient Air. Environmental Health Perspectives, 2006, vol.114(11), 1662-1669.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17864	7					Lopez AD, Mathers CD, Majid Ezzati M, Jamison DT, Murray CJL. 2006. Global Burden of Disease and Risk Factors. Published by Oxford University Press, 165 Madison Avenue, New York NY 10016, and The World Bank, 1818 H Street NW, Washington, DC 20433, USA.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17865	7					Markandya A, Bigano A and Roberto Porchia R, editors. 2010. The Social Cost of Electricity: Scenarios and Policy Implications. Fondazione Eni Enrico Mattei. Edward Elgar Publishing Ltd, Cheltenham, UK.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17866	7					Mathers CD, Bernard C, Iburg K, Inoue M, Ma Fat D, Shibuya K, Stein C, Tomijima, N. 2003. The Global Burden of Disease in 2002: data sources, methods and results. Geneva, World Health Organization (GPE Discussion Paper No. 54). Downloaded from <a href="http://www.who.int/healthinfo/boddalysmphreferences/en/index.html">http://www.who.int/healthinfo/boddalysmphreferences/en/index.html</a> .	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17867	7					Miller BG, Hurley JF. 2003. Life Table methods for quantitative impact assessments in chronic mortality. J Epidemiol. Community Health, 57: 200-206.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17868	7					Mitchell, R.C. and R.T. Carson 1989. Using Surveys to Value Public Goods: the Contingent Valuation Method. Resources for the Future. Washington, DC.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17869	7					Murray, C.J.L., Acharya, A.K., 1997. Understanding DALYs. Journal of Health Economics 16(6) 703-730.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17870	7					NRC 2010. "Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use". National Research Council of the National Academies Press. National Academies Press, 500 Fifth Street, NW Washington, DC 20001.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17871	7					ORNL/RFF 1994. External Costs and Benefits of Fuel Cycles. Prepared by Oak Ridge National Laboratory and Resources for the Future. Edited by Russell Lee, Oak Ridge National Laboratory, Oak Ridge, TN 37831.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17872	7					Pope CA, Hill RW& Villegas GM 1999. "Particulate air pollution and daily mortality on Utah's Wasatch Front". Environmental Health Perspectives, vol.107(7), 567-573.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17873	7					Pope CA, RT Burnett, MJ Thun, EE Calle, D Krewski, K Ito, & GD Thurston 2002. "Lung cancer, cardiopulmonary mortality, and long term exposure to fine particulate air pollution ". J. Amer. Med. Assoc., vol.287(9), 1132-1141.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17874	7					Rabl A 2003. "Interpretation of Air Pollution Mortality: Number of Deaths or Years of Life Lost?" Journal of the Air & Waste Management Association, Vol.53(1), 41-50.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17875	7					Rabl A, Thach TQ, Chau PYK and Wong CM. 2011. "How to determine life expectancy change of air pollution mortality: a time series study". Environmental Health, 2011, 10:25.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17876	7					Reiss R, Anderson EL, Cross CE, Hidy G, Hoel D, McClellan R, Moolgavkar S. 2007. "Evidence of Health Impacts of Sulfate- and Nitrate-Containing Particles in Ambient Air". <i>Inhalation Toxicology</i> , 19:419–449.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17877	7					Samet JM, Dominici F, Zeger SL, Schwartz J, Dockery DW. 2000. "The National Morbidity, Mortality and Air Pollution Study, Part I: Methods and Methodologic Issues." Research Report 94, Part I. Health Effects Institute, Cambridge MA. Available at <a href="http://www.healtheffects.org/">http://www.healtheffects.org/</a>	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17878	7					Schwartz J, Coull B, Laden F and Ryan J. 2008. "The Effect of Dose and Timing of Dose on the Association between Airborne Particles and Survival". Environmental Health Perspectives, vol.116 (1), 64-69	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17879	7					Spadaro JV and A Rabl 2008. "Estimating the Uncertainty of Damage Costs of Pollution: a Simple Transparent Method and Typical Results". Environmental Impact Assessment Review, vol. 28 (2), 166–183.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17880	7					UNSCEAR 2000. REPORT Vol. II SOURCES AND EFFECTS OF IONIZING RADIATION United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR 2000 Report to the General Assembly, with scientific annexes Volume II: EFFECTS, ANNEX G Biological effects at low radiation doses.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17881	7					WHO 2003. "Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide". World Health Organization report EUR/03/5042688.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17882	7					Wilson R and EAC Crouch, 2001. "Risk-Benefit Analysis". Harvard University Press, Cambridge, MA.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17883	7					Wilson R and JD Spengler, editors 1996. "Particles in Our Air: Concentrations and Health Effects". Harvard University Press, Cambridge, MA.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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17884	7					Woodruff TJ, Grillo J, Schoendorf KC 1997. "The relationship between selected causes of postneonatal infant mortality and particulate air pollution in the United States". Environ Health Perspect, vol.105(6), 608-612.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
17885	7					Zanobetti A, Schwartz J. 2008. "Mortality displacement in the association of ozone with mortality: an analysis of 48 cities in the United States". Am J Respir Crit Care Med;177(2):184-9.	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17886	7					Zmirou D, Balducci F, Dechenaux J, Piras A, Filippi F, Benoit-Guyod JL. 2007. "Meta-analysis and dose-response functions of air pollution respiratory effects". Revue Epidemiologie et Sante Publique 45(4):293-304 (1997).	Taken into account. This is a very well-meaning attempt to alert us to relevant literature. However, we cannot start by reviewing the epidemiological or toxicological literature on individual pollutants emitted by power plants. We have not found burden-of-disease type overviews that attribute DALYs to individual emission sources (rather, more abstract, urban air pollution). The main purpose of the work here is to illuminate differences between different energy technologies which are relevant for future use, and so we started with analyses of individual energy technologies.
18646	7					The FAQs - clearer messages please.	Taken - into account. The frequently asked questions (FAQ) have been reformulated in order to address issues related to the energy supply sector only. In addition, their content has been improved.
10795	7					The chapter misses forest plantations in degraded soils of the tropics. As a renewable energy source, forest plantations can capture large amounts of CO2, while suppling woodchips for replacing coal in power plants and also replacing coke in ironmaking. Charcoal ironmaking is traditionally done in Brazil, with net CO2 capture, as compared to ironmaking with coke. Sources of reliable information: Brazil 'Ibama, the national Institute for Environment and Nature; AMS, Associacao Mineira de Silvicultura, and Brazils Forest Service of the Ministry of Environment.	This is not the subject of this chapter. See Introduction. Forest issues are treated in chapter 11.
3635	7					Table 7.2 hardly readable.	Taken in to account - readability has been improved.
3637	7					Figure 7.11 hardly readable.	Taken into account. Figure has been deleted.
3636	7					Figure 7.9 hardly readable.	Accepted
7478	7					In urban areas, there is a choice of fuels and price of the various fuels determines what people buy. LPG is the most convenient fuel, but it has to be bought in bulk. Fuelwood, charcoal and kerosene can be bought in small or large quantities. Electricity is expensive and supply is unpredictable. Thus, the choice depends on price, availability, preference and the type of food/ beverage that is being prepared.	Noted. That is more the subject of chapter 9.
15509	7					Resources and resource availability - Very well presented. Suggestion to introduce somewhere a paragraph (introduction words) on "available" resources and "climate change patterns". In another word, resources already well identified and other potential ones are already enough to go much over than a 450 ppm trend - see IPCC SRREN, IEA or others.	Noted. Thank you. Resources definitions which are in use in the chapter are given in section 7.4

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5328	7					The table hides that the high growth in some sectors is due to high subsidies (feed-in-tariffs). It would be interesting to know the growth of capacity per dollar of a feed-in tariff.	Rejected - the impact on policy on RE development is addressed elsewhere in the chapter. The statistic suggested by the comment is not available in the peer reviewed literature, to our knowledge.
5235	7					The legend of Figure could be more informative by giving the names of the source sectors.	Taken into account. The section has been deleted.
11158	7					The grouping of countries e.g. Africa as a block is misleading. Further, regrettably, China and India dominates statistics on Developing countries and overshadows most other developing countries. In future, it might be worthwhile to consider distinguishing between BRICS (Brazil, India, China and South Africa) and other developing Countries. Data on Africa is sparse and where available, is hugely over-aggregated. Understandably, it is difficult to present accurate regional data on specific regional initiatives. Recent discoveries of oil, gas and coal in many of the Countries in Eastern Africa - Sudan, Somalia, Tanzania, Uganda, Kenya will impact on the regions CC mitigation efforts. It might be important to highlight/mention these discoveries, whatever the scale, because they will impact on renewable energy initiatives that the countries were embarking on..	Noted. We understand those concerns and tried to make this point clear. The WGIII has regional split we trying to stick to. In some cases separate countries are mentioned in the text. But significant detailization will overload figures and made them hardly readable. We are stressing the importance of China and India in sections 7.2 and 7.3. But there would be a battle for showing China separately.
10540	7					Question to ask for whole chapter is what is new since AR4. Seems to be mainly regurgitation of the same info (also the case for other chapters I realise - including Transport!).	Agreed - focus should be on what's new since AR4 with some allowance for covering key fundamental points to orient reader to a given topic (i.e., whether it is new since AR4 cant be the only criterion).
3008	7					This table lacks the citation of a recent and comprehensive study undertaken by the World Bank in Brazil: Low Carbon Emission Scenarios in Brazil. Please see <a href="http://siteresources.worldbank.org/BRAZILEXTN/Resources/Brazil_LowcarbonStudy.pdf">http://siteresources.worldbank.org/BRAZILEXTN/Resources/Brazil_LowcarbonStudy.pdf</a> .	Rejected - There is no table 7.5 at this page. If figure 7.5 is referred to, then it just shows historical evolution with no scenarios at all. Table 7.5 is at p.55.
3000	7					Figure 7.10 is not clear. What is the label of axis-x?	Accepted. Figure has been corrected.
5934	7					assessment of the various technologies, and the LCA approach could be seen as uncertain and opaque. Is it necessary to base the IPCC work on life-cycle assessments?	Rejected - the methodological annex for details on the LCA method.
5936	7					The representation of uncertainty of resource assessments by height of columns seems to hide the large potential for hydropower, which due to a precise resource assessment is represented by an almost invisible line.	Accepted - new figure makes it somewhat more visible

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2937	7					It is not clear to this reader (and I daresay to many others) what the authors include and exclude in the "energy sector" which this chapter is supposedly about, and how that relates to the coverage of other chapters in this volume. Thus we read in the chapter summary (p5 lines 2-3) "the energy sector...provides only 45 % of energy-related GHG emissions". So where are the other 55% ? One is left to presume that the other 55% are attributable to transport, buildings, and industry (chapters 8,9,10) . Or do these only add up to 45% or 50%? This division between chapters both conceptually and numerically needs to be clarified, or readers will be very confused. Section 7.1.1 (where one might expect a clear and comprehensive discussion of these issues) has only one short and inadequate paragraph (p7 line 46- p8 line 3) , with no reference to how the related chapters fit in. The discussion in chapter 4 about "emissions measured by source" and "emissions measured by consumption" is also relevant here.	Accepted - a diagram in the introduction now clarifies the system boundaries.
14895	7					There is a substantial overlap between Chapter 15 and Chapter 7 section 11 on policies please align and refer rather than duplicate and contradict	Accepted - text revised.
17201	7					The chapter is densely populated with grey literature (incl. Conference papers) and non-peer reviewed articles. The CLAs are requested to make a thorough review of the material cited throughout the chapter.	Accepted - most of the literature is peer-reviewed. Beyond peer-reviewed journals, references are made to reviewed publications of IPCC, IEA and other recognized bodies. The quality of other sources was assessed as suggested.
17235	7					Publications in "Energy Procedia" are usually only conference proceedings that are not peer reviewed.	Noted.
17280	7					The scope of the chapter is not entirely clear. It would be valuable to frame the scope of the chapter in terms of the mitigation options that are taken into account. Are only emission reductions in the energy conversion sector (e.g. electricity production) considered? Or also the provision of alternative, low-carbon combustible energy carriers (such as biofuels for transportation)? It should also be clarified that any options related to fuel switch or energy demand reductions are discussed in the sector chapters.	Accepted - text revised.
17205	7					The sub-section is not really summarizing the AR4, e.g. there is a reference to IEA(2012).	Taken into account - comment is obsolete. Overview of AR4 was deleted.
3408	7					This is a section discussing issues that seem to belong to other chapters and that are treated here quite superficially. Incredibly poor text in pages 65 lines 9 to 30, from trivial statements (line 9-11) to random choice of a nice case example in Denmark, which is again poorly explained . Another example of extremely low quality rethoric is between lines 37 and 43 in page 65. Another example: we should agree that it is trivial to note that "...agriculture which is a seasonal activity" in line 1 page 66, followed by irrational, opinionated, rethoric. DELETE SECTION ? Section 7.10.5 is much better (factual and informative) and could be saved and put elsewhere.	Taken into account - text has been rewritten.
17943	7					An introductory sentence along the example of Chapter 9 referring to the agreement reached in Wellington (p. 36) might be helpful for readers: "Barriers and opportunities are referred to as conditions that hinder or facilitate the implementation of the analyzed measures."	Rejected - this is a matter of the glossary
3639	7					Delete or massively reduce to save space as overlaps with chapters 4.3.5, 6.3.7, 6.7.1.	Accepted - text is reduced considerably.
3640	7					Delete or massively reduce to save space as overlaps with chapter 4.3.8.	Taken into consideration. Revised.
17944	7					The discussion provided in this sub-section should be linked to the section 2.4.4.2 that provides a number of important references.	Noted.

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3641	7					Delete or massively reduce to save space as overlaps with chapter 3.4.2, 3.11, 4.3.3.	Rejected. This section is specific to the energy sector
17951	7					Further issues that might be discussed in this section are aesthetic perceptions of wind energy and grid technologies, infrastructure lock-in with respect to legal aspects, liability for accidents (as in the case of off-shore wind).	Taken into consideration. But the reviewer does not provide references. We have looked for further references.
3642	7					Delete or massively reduce to save space as overlaps with chapters 4.3.2, 4.1.2.3, 4.6.	Rejected. This is a cross-cutting issue, and we are addressing the specifics of capacity building in the energy sector
3409	7					This is a section of overall good quality but I am not sure if it belongs to this chapter. In particular section 7.11.2 must be treated in much more details in other chapters of this AR?. Only one comment on text in page 68, line 32-34: is it sensible to rely on technologies to be deployed after the middle of the 21st century?	Taken into account - the description of the instruments and their economic justification is left to the policy chapter (13- 15). The text on page 68, line 32-34 has been deleted.
17232	7					The study below shows that technology policies can help to overcome the negative effects of delayed carbon pricing. In this study technology policy is not a complement, but a temporal substitute for a missing carbon price. The study also analyzes the regional distribution effects. Bauer N, Baumstark L, Leimbach M (2012): The REMIND-R model: the role of renewables in the low-carbon transformation—first-best vs. second-best worlds. Climatic Change, online first. DOI 10.1007/s10584-011-0129-2	Rejected - space constraints do not allow for a discussion related to the justification of single instruments. This is to be done in chapter 13-15 or 3.
3410	7					This is an excellent section for a FOD. Authors responsible for this section should be encouraged to read and critically comment on previous sections j j .	Noted.
4465	7					This section offers little in the way of sectoral policies. There is no balance in the discussion since most CO2-emitting sectors are omitted. The discussion on policies for electricity generation are general, rather than practical. There is no discussion of what works and what does not, across a range of countries and time periods. Therefore, there is little offered to the reader to inform decision making in the future. To illustrate, Table 7.6 offers a summary of policy options. However, the question remains on how effective any of these policies has been in the past, whether they should be continued and can deliver on the desired avoided CO2 volumes in the required time. Thus, a more analytical discussion is required, rather than repeating the generalizations and concepts that most readers are familiar with already.	Accepted - this section should not discuss policy issues in detail. This is done in 7.11. The policy discussion from table 7.6 has been removed.
11544	7					Why is this here? Chapter 6 is the place for it, this is why there is a chapter 6, right?	Reject - Chapter 6 aims at an integrated view of the transformation, while this section looks at the implications of the transformation for the energy sector.
10688	7					I can't understand the importance of this figure. It seems that it is only meant to show the diversity of technology utilization by country in different models and no further implication is not shown.	Taken into account - comment is obsolete. Figure has been deleted.
3643	7					Delete or massively reduce to save space. Overlaps with chapter 6.3.	Noted - but figure removed.
11872	7					This section seems to gloss over a lot of work that has been done to consider different methods for considering cumulative versus instantaneous conditions/effects, and how they address (or don't address) the issue of irreversible climate change events/processes. Why are all of these considerations /alternatives seemingly ignored?	Rejected. The issue is already covered in detail in chapter 6

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3644	7					Delete or massively reduce to save space. Overlaps with chapter 6.3.2.	See comment 11872. Luckow (2012) should be replaced with a citation to Edmonds, J., Luckow, P., Calvin, C., Wise, M., Dooley, J., Kyle, G., Kim, S., Patel, P., Clarke, L., 2012. Can Radiative Forcing Be Limited to 2.6 W/m2 at the end of the 21st Century Without Negative Emissions From Bioenergy and CO2 Capture AND Storage? Climatic Change.
3645	7					Delete or massively reduce to save space. Overlaps with chapter 3.10.2., 6.3.4, 6.3.6.3.	Taken into account - comment is obsolete. Figure was removed.
17236	7					the issue of CO2 emission statistics is not only a gap in knowledge but a gap in preparation for poolicies. Emission policies with caps require national statistics of emissions. If these statistics are not made available and accepted by national institutions there might be a serious lack of institutional capacity building that will deply effective and comprehensive policies to reduce GHG emissions.	Noted.
3012	7					I suggest including the discussion about gaps related to GHG metrics. Temporal issues are of fundamental importance in the evaluation of mitigation strategies dependent on multi-gas comparisons. First, it isn't clear which climate change impact the metric is a proxy for. The term "warming potential" is misleading, for the relationship between the radiative forcing which results from a pulse emission and its warming potential is not a simple one, as two gases with the same GWP will not necessarily cause the same temperature change and climate impact. Second, in spite of advances, much uncertainty remains regarding the appropriateness of GWP as a metric for determining equivalence of short-lived gases or a gas such as CH4, which may be regarded as short-lived relative to CO2. Studies show the dependence of the GWP for short-lived gases on geographic origin of emissions and on the effect of feedbacks. Also, there are two aspects of time which are not properly addressed when the fixed GWP metric is applied: the moment when an emission pulse occurs, and the choice of time-horizon and target year to be used for comparison of climatic impacts. This means that pulse emissions are weighted equally, regardless of how far the emission is from the target year, a clear disadvantage for mitigation policies with specific temporal objectives. The fact that GWP is time-invariant can cause the overestimation in multi-gas equivalency of short-lived such as CH4, particularly when shorter time-horizons are used.	Noted - the reviewer is right in emphasizing this, however, gaps related to GHG metrics are to be addressed in chapter 6 and the methodological annex.
17209	7					The issue of traditional biomass is not considered here. However, this is an important part of the energy sectors in developing countries.	Only two examples with highest penetration are taken for power generation - coal and gas. Biomass and oil are not mentioned. But they are in table 7.1.
17211	7					The sub-section doe snot discuss the role of international energy technology markets. The availability of alternatives and the diffusion rates of new technologies this is very important, especially for the case of renewables and nuclear. The international spread of technology costs (e.g. Solar PV) is of great importance. This is important for the IPCC AR5 because this is a key for international technology policies to accelerate the diffusion rates of technologies.	Rejected - space constraints do not allow to go into the details here.

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17212	7					The sub-section does not discuss the role of oil prices. This is important because the mitigation costs of CO2 from the energy sector very much depend on the price of oil because (i) CO2 abatement costs are the opportunity costs of not using fossil fuels in traditional ways and (ii) the oil price has a large impact on gas and coal prices. This is still true, though the link of oil and gas prices has been uncoupled in the US recently.	This introductory part of the chapter showing the present status in energy sector. Section 7.3.3 was removed
17213	7					The CLA may want to consider the emissions of sulphur, black carbon, VOCs as well. Gas Flaring might also be interesting because it emits a lot of black carbon that influences albedo in the arctics.	Taken into account. The section has been deleted.
11848	7					The discussion of energy-related CO2 and GHG emissions is quite confusing. Does energy-related emissions refer to emissions from the total fuel cycle (or life cycle) emissions? If so, can this be stated more clearly and succinctly?	Taken into account. The section has been deleted.
11850	7					This section lists a lot of data and facts without providing a great deal of analysis or interpretation (e.g. section 7.3.2.2). Is it possible to provide these data in tables, or better, figures that are easier to digest and interpret? This could also shorten the text.	Taken into account. The text was shortened.
2997	7					All discussion misleads the fact that petroleum reserves (conventional or not) can increase not only by discoveries but also by EOR. This is an important issue, since CO2 capture and storage can either improve EOR or compromise it.	Noted Comment is valid, but space limitation exclude to go into the details here.
2998	7					Again, in all section 7.4 there is the need to better differentiate between shale oil and oil shale. Authors seem to not recognize this important distinction and use wrongly both concepts.	Rejected: The distinction can only be made where time and space permits. Use here is consistent with the purpose of the text.
12916	7					Residual heat from industrial processes (steel, refineries etc.) and power production constitute a large and untapped energy resource that could be used for district heating (and cooling). This resource could replace fossil fuels in district heating networks or biofuels which then could be used for other purposes.	This resource is widely used in some countries like Russia for example. As too industrial waste heat this is the subject for chapter 10. Here we may reflect that this is carbon free resource
17219	7					The section is not reviewing the most recent literature. The CLAs are strongly recommended to improve this section. The section should also comprise text and quantifications on EROI, co-emissions (including deforestation and peat land loss for tar sands), policies like concessions and royalties. Regarding co-emissions a review of shale gas is required.	Rejected - not possible given space limitations.
16097	7					The beginning of this section could be shortened and clarified. The first paragraph is there for criticism and rebuttal in the next ones. Maybe a more direct approach would be clearer and shorter.	Accepted - text shortened
16098	7					The depletion issue is clear only in the end from the point of view of climate : p.26 line 17 it is explicit. But the section should precise who disagrees with the vision of that much available hydrocarbons, and if the difference between sources could be removed by more knowledge or research.	Rejected: This is extensively done in the GEA reference.
16099	7					A graph comparing these fossil reserves with the carbon budgets in order to limit global warming to 2°C or less is needed here, updated from AR4. This could be in addition to table 7.2	Rejected due to space limitations
16100	7					Wouldn't ex-coal liquids be relevant in this section?	Rejected - no, this section is about resources not their eventual use
6798	7					When covering unconventional fossil fuel resources, it is extremely important to detail the additional carbon emissions associated with these resources and the large carbon emissions potential of these reserves if they are tapped.	Accepted- text revised.

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4080	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 : <a href="http://www.ipcc.ch/ipccreports/tar/vol4/english/fig7-5.htm">http://www.ipcc.ch/ipccreports/tar/vol4/english/fig7-5.htm</a> . 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 <a href="http://www.peakoil.org.au/charts/world.oil.gas.coal.production.1965-2050.gif">http://www.peakoil.org.au/charts/world.oil.gas.coal.production.1965-2050.gif</a> 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: Space limits prohibit this detail.
17221	7					The sub-section does not consider the most recent findings of WEC regarding the additional recoverable uranium at costs higher than 80US\$ per kg Uranium	Accepted - and updated to reflect Red Book 2012
2999	7					it would be interesting to mention that huge amounts of natural uranium equivalent remain in the military reserves of the USA and Russia. However, the Red Book cited in the report acknowledges that the uranium mining capacity numbers are higher than the possible real production from mining.	Rejected: Comment correct - but space limitations prohibit this level of discussion.
16228	7					I guess it'll be good to add a Matrix as a comparison between energy that could be obtained through the application of each type of new and renewable energies compared to the cost of financial investment, and by imposing a best suitable conditions for that and also impose worst, I suppose that comparison will be useful purely for developing countries and least developed countries	Rejected - though this would indeed be useful, it is simply not available in the peer reviewed literature
16808	7					Previous sections were helpful because of inclusion of costs -- this section omits any discussion of costs or economics and is therefore less helpful. Policymakers need some context.	Accepted - text has been amended to be clear that no overarching single cost metric has been used for RE potential studies. As we are forced to refer to the available literature we are unable to provide a full discussion of cost based potential estimates.
3392	7					I do not have sufficient technical expertise in all subsections under 7.5 but I strongly feel that there is something wrong in the current draft. Generic text is mixed with disconnected pieces of valuable information. Obvious "text-book" ideas, that could be omitted, are mixed with highly technical excursions to detail, that are unnecessary in an IPCC report. In summary: a poor job by the drafting authors. Only some detailed examples below.	Noted.
17749	7					there is no discussion on behavioural aspects as the section heading suggests	Taken into account - the heading is used for all sector chapters. It fits to end use sectors, but does not really apply to energy supply.
16109	7					Consumption patterns -in French Sobriété- and even most of energy efficiency gains are absent in this section. They should be mentioned as an introduction or recall of the other chapters. Otherwise it is misleading for decisionmakers in terms of relative size. Energy efficiency has to be recognized as a wider potential than all other options.	Taken into account - the system boundaries are described in chapter 7.1. Energy efficiency at the consumer level is discussed in the demand sectors.
16810	7					This section may be shortened -- it also lacks the very important discussion of relative costs ... simply listing the technology options without showing how their costs compare to other technologies is not that helpful.	Noted.

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13294	7					It is worth mentioning in this section that decarbonisation of the heat and transport sectors has the potential to require significant additional distribution network capacity, as heat pumps and electric vehicles are adopted. It is also worth mentioning that the amount of additional capacity required will depend on the patterns of consumption from these new demands, which depend on whether smart infrastructure is introduced (e.g. smart EV charging overnight vs. charging at the early evening peak on returning home from work have an order of magnitude difference in their costs of electricity distribution)	Accepted - short paragraph added to the end of 7.5.2
16812	7					While there is potential to squeeze out gains in transmission and distribution of electricity, these seem relatively small compared to costs -- why spend so much space on it in report unless these are indeed much less costly on a \$/ton basis than other mitigation options in generation.	Noted. Actually, this is a fair comment - A possible answer is to demonstrate that savings won't come easily from this area of investment. Final sentence added to reflect this comment.
7733	7					The whole section gives the impression that CCS is a dominated technology, with risks under control and competitives costs. CCS is still to be developed in order to overcome a variety of barriers. Deep detailed studies are needed to correctly assess the risk of CO2 leakage. Choosing an adequate site for CO2 storage has no methodological correct answer and this is a concern that needs to be addressed. Projects like the CCS with storage in saline aquifers as the one in Wayburn in Canada, have been stopped, which is a clear sign that some important difficulties remains.	Rejected. No scientific evidence or body of peer reviewed literature is offered in support of this observation .The totality of what is written about CCS in all parts of Chapter 7 seems balanced. But because it is broken up and scattered it lead to many comments like this. The new version has been improved accordingly.
16038	7					In this section the description of CCS can be shortened. But it has to include the discussion about the risks and the uncertainties of CCS and the possibility of the use of CO2 after sequestration CCU (Carbon capture and usage) for example with algae.	Rejected. No scientific evidence or body of peer reviewed literature is offered in support of this observation .The totality of what is written about CCS in all parts of Chapter 7 seems balanced. But because it is broken up and scattered it lead to many comments like this. The new version has been improved accordingly.
16815	7					This section would benefit greatly by inclusion of discussion re the relative cost of renewable energy vs. other low emitting energy technologies. Models show that renewable energy is a very important component of a low emitting technology set, but not the only part of a low cost solution. If restrict the future to only use renewable energy technologies, the models indicate the cost is several times greater than if we allow nuclear and CCS technologies to deploy. See chart 6.	Rejected - very good points, but better addressed in the cost and scenarios sections of the chapter. Please review those sections in the next round to ensure that these important points are addressed.
3003	7					The manuscript summarized very well the current status of nuclear energy. However, the promise that Generation III designs could be safer, but simpler and cheaper has been shown to be inaccurate. Moreover, in spite of the optimism for the nuclear industry in China, there are still significant issues about whether this country will have as open and accountable processes for the nuclear industry as those in other countries.	Rejected - The reference to smaller modular reactors and potential for improved economics is conditional. Discussion of nuclear industry in China is beyond the scope of this section.

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17224	7					The sub-section does not discuss the issue of refurbishment costs of existing nuclear power plants for life-time extension up to 60 years. These costs are substantial. The CLAs are requested to include this into the review. See 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 - not supported by available data. Life extension policies vary across regions. Life extension is common in the US, and 73 reactors in the US have had their operating license extended from 40 to 60 years (US NRC). Life extension is a more economically competitive option to building new power plants.
17229	7					The sub-section is not discussing the international dimensions of using nuclear power. This includes especially the issue of proliferation. Expanded use of nuclear power for climate change mitigation also requires a more stringent framework to avoid proliferation. Heree international security and cliamte policies are strongly interrelated.	Taken into account - section 7.5.5 ends with "Continued use and further expansion of nuclear energy worldwide as a response to mitigating climate change require greater efforts to improve the safety, economics, uranium utilization, waste management, and proliferation concerns of nuclear energy use." Section 7.7 discusses proliferation risk. Limited space for discussion of international security dimensions.
17230	7					regarding large scale integration of renewables for CO2 emission reductions the study by Haller et al.; Energy Policy, Vol. 47, pp282-90 is useful to consider here. The study shows that the same level of emissions in the EU-NorthAfrica region can be achieved at lower costs, if international grid integration is available.	Rejected - space constraints do not allow to go into every detail here.
9243	7					Please add the 'access to the electricity' itself in the developing regions if possible.	Rejected - the comment seems to be misplaced.
16826	7					Could be significantly shortened. No context, not particularly useful in terms application or policy formation. Can you provide range for how costly potential improvements are on a \$/ton basis so policymakers can know if these improvements are likely in a low carbon price environment or a high carbon price?	Accepted - content of the text has been improved. Cost issues are to be discussed in section 7.8.2.R1193
3399	7					This is really superfitial again, and with too many references to support "text-book" generic ideas. Key figures from the key reports to highlight the existing infrastructure for fuel supply systems should be highlighted (a table?). May be delete the paragraph on H2 transport (line 23-34)...	Taken into account: Entire hydrogen paragraph has been revised.

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6432	7					<p>This section has a lot of references for large ocean vessel transportation and offshore transportation, but only a couple for onshore pipeline transportation. The reference to Johnson and Ogden is not the best work or most productive work. Here is some relevant and more thorough text, with more and more appropriate references:" A large and integrated network of dedicated CO2 pipelines will be needed to transport enormous volumes of CO2 between spatially distributed CO2 sources and CO2 storage reservoirs. For example, in the United States, this could require building a network to carry a larger volume of CO2 than domestic oil consumption (1). Large pipelines that can aggregate CO2 enjoy tremendous economies of scale (e.g., 2), enabling operators to build cheaper and more resilient CO2 networks (3), though networks will likely evolve over time starting with smaller unconnected networks (4) and progressing to cooperative systems involving multiple stakeholders (5). The pipeline network will be integral to a cost-effective and reliable CCS system, for example, being able to flexibly route CO2 sources and sinks with varying supplies (e.g., changes in electricity production) and reservoir performance (e.g., potential leakage) (6).</p> <p>1. Middleton RS, Keating GN, Stauffer PH, Viswanathan HS, &amp; Pawar RJ (2012) Effects of geologic reservoir uncertainty on CCS infrastructure. International Journal of Greenhouse Gas Control 8:132-142.                  2. Kuby MJ, Middleton RS, &amp; Bielicki JM (2011) Analysis of cost savings from networking pipelines in CCS infrastructure systems Energy Procedia 4:2808-2815.                  3. Middleton RS &amp; Bielicki JM (2009) A scalable infrastructure model for carbon capture and storage: SimCCS. Energy Policy 37(3):1052-1060.                  4. Johnson N &amp; Ogden J (2011) Detailed spatial modeling of carbon capture and storage (CCS) infrastructure deployment in the southwestern United States. 10th International Conference on Greenhouse Gas Control Technologies 4.                  5. Middleton RS, Wei R, Kuby MJ, Keating GN, &amp; Pawar RJ (2012) A dynamic model for optimally phasing in CCS infrastructure. Environmental Modeling and Software 37:193-205.                  6. Middleton RS, et al. (2012) The cross-scale science of CO2 capture and storage: from pore scale to regional scale. Energy &amp; Environmental Science 5(6):7328-7345.</p>	Noted. The references provided by the reviewer are not inherently any better than those already included in the text.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
3401	7					Excess of references for simple ideas. Do you really need 9 references to support the obvious statement "Effect of climate change on overall energy demand will vary geographically". In general, this is a poor section 7.7, full of trivial and superficial ideas, combined with a pretentious use of references. Just one example: Lines 40-42 in page 44: do you need to refer to two papers to support this thermodynamic evidence?. These ideas are much better treated in section 7.8.1 which reads excellent. Delete most of this section?	Rejected - The IPCC decided upon the chapter sections, and this one must be included. The WGII report covers the issues covered here in depth, but we must nonetheless at least summarize the basics of the literature. With planned revisions, we believe that the text will accurately reflect the literature, and point readers to some of that literature. While it is true that one need not have an excess number of citations, one purpose of IPCC documents is to help the reader identify relevant literature to get started with, so we do not wish to severely restrain citation numbers. We will look to eliminate some citations, however, in accordance with the comment. Given space constraints, and due to the WGII report, we are not able to address the issues discussed in this section at more than a surface/summary level.
3005	7					I suggest including the following references. Pryor, S. C., R. J. Barthelmie, and E. Kjellström, 2005a. Potential climate change impact on wind energy resources in northern Europe: Analyses using a regional climate model. <i>Climate Dynamics</i> 25: 815–835. Pryor, S. C., J. T. Schoof, and R. J. Barthelmie, 2005b. Climate change impacts on wind speeds and wind energy density in northern Europe: Empirical downscaling of multiple AOGCMs. <i>Climate Research</i> 29: 183-198. Pryor, S. C., R. J. Barthelmie, E. Kjellstrom, and J. Mann, 2005c. Potential climate change impacts on wind energy resources in northern Europe. <i>Geophysical Research Abstracts</i> 7: 01544. Pryor, S. C., and R. J. Barthelmie, 2010. Climate change impacts on wind energy: A review. <i>Renewable and Sustainable Energy Reviews</i> 14: 436-437.	Rejected - These are all excellent citations, but the majority if not all of them are included in the IPCC SRREN, which is the source document used for discussion of possible wind energy impacts. That meta-study includes these citations by reference.
17231	7					The study below quantifies the emission reduction potentials in the energy sector. The authors might cite this. Luderer L, Pietzcker RC, Kriegler E, Haller M, Bauer N (2012): Asia's Role in Mitigating Climate Change: A Technology and Sector Specific Analysis with ReMIND-R. <i>Energy Economics Special Issue on the Asian Modeling Exercise</i> . Accepted for publication.	Rejected - space constraints do not allow to go into the details here.
11549	7					This subsection is not very well structured. Pls agree on a generic structure for how to deal with different technologies in which order and stick to it (first RE issues, then CCS, then... etc) - coordinate also with Ch 6.	Accepted - the text is revised accordingly.
10053	7			48		The costs for new nuclear power plants are unclear and scientific literature should be quoted. Either the shown nuclear cost figure is based on a scientific publication (reference should be added) or this range must be much larger. In the UK the nuclear industry asks for a feed-in tariff for new nuclear power plants of approx 19cents/kWh. The current figure and the range is misleading.	Taken into account - the cost of nuclear power plants are reconsidered and based on IEA data.

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10054	7					This section needs significant more work, as the current status does not provide the required level of information. Table 7.5 provides an incomplete overview from mostly grey literature. The curves should also be part of this section rather than only writing about the curves.	Taken into Account - This section gives context to the relative economic potential of energy supply options, and while the broader economic assessment in other chapters is referenced, these links will be made more comprehensive. The summary table 7.5 is now removed with multiple references back to the full MAC discussion in 3.10.2.
3638	7					Concentrate on energy security issues. Massively reduce rest to save space as overlaps with chapter 5.10.	Rejected. There is virtually no overlap with 5.10
17933	7					Introductory sentences like the ones in Chapter 10 might be a good idea to prepare the reader for the following discussions: "Besides economic cost aspects, several other aspects have implications on the final deployment of mitigation technologies. Co-benefits, co-costs, risks and uncertainties associated with alternative mitigation technologies as well as public perception thereof can affect investment decisions of companies and priority setting of governments."	Accepted. An introductory section has been inserted.
9264	7					The use of depleted oil/gas fields for CCS could extend the socioeconomic viability of oil towns/industries.	Rejected. No scientific evidence/publications provided to support suggested changes. This might be true but this seems like a minor nuance of a point. I'm also not aware of any literature on this point. Lastly, it is not clear (again there is no literature on this point) as to how large the rents would be from storing CO2 in a depleted oil field and who would share in those rents compared to oil production. The reviewer makes an interesting point but I don't think it warrants a change in what is already a too long Chapter 7.
17936	7					Please consider reviewing the following paper: Steckel, Jan, Robert J. Brecha, Jessica Strefler, Michael Jakob und Gunnar Luderer (in review): Development without energy? Assessing future scenarios of energy consumption in developing countries. Working Paper. Submitted to Ecological economics ( <a href="http://www.pik-potsdam.de/members/steckel/publications/development_energy_new">http://www.pik-potsdam.de/members/steckel/publications/development_energy_new</a> )	Noted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
3002	7					<p>The manuscript emphasizes the issue of how integrating CCS-baseload plants into grids, but it does not emphasize the fact that:</p> <p>a. Depending on the technology, CCS will increase the water demand of the plant, and can even undermine its application to some facilities. See Feeley, T.J., Skone, T.J., Stiegel, G.J., McNemar, A., Nemeth, M., Schimmoller, B., Murphy, J., Manfredi, L., 2008. Water: A critical resource in the thermoelectric power industry. Energy, 33, 1–11. Zhai, H., Rubin, AND., Versteeg, P., 2011. Water Use at Pulverized Coal Power Plants with Postcombustion Carbon Capture and Storage. Environmental Science and Technology, 45, 2479 - 2485.</p> <p>b. Post combustion capture plants generate toxic residues. This can undermine the large scale application of this option. See THITAKAMOL, B.; VEAAB, A.;ARONWILAS, A. Environmental impacts of absorption-based CO2 capture unit for post-combustion treatment of flue gas from coal-fired power plant. International Journal of Greenhouse Gas Control, v. 1, n. 3, p. 318–342, jul 2007. STRAZISAR, B. R.; ANDERSON, R. R.; WHITE, C. M. Degradation Pathways for Monoethanolamine in a CO2 Capture Facility. Energy &amp; Fuels, v. 17, n. 4, p. 1034–1039, 1 jul 2003.</p> <p>c. Given the energy penalty, it is worth estimating the life cycle emissions of power plants with CCS. This was proposed by FERON, P. H. M. Exploring the potential for improvement of the energy performance of coal fired power plants with post-combustion capture of carbon dioxide. International Journal of Greenhouse Gas Control, v. 4, n. 2, p. 152–160, mar 2010. HERTWICH, E. G.; AABERG, M.; SINGH, B.; STRØMMAN, A. H. Life-cycle Assessment of Carbon Dioxide Capture for Enhanced Oil Recovery. Chinese Journal of Chemical Engineering, v. 16, n. 3, p. 343–353, jun 2008. KOORNNEEF, J.; KEULEN, T. VAN; FAAIJ, A.; TURKENBURG, W. Life cycle assessment of a pulverized coal power plant with post-combustion capture, transport and storage of CO2. International Journal of Greenhouse Gas Control, v. 2, n. 4, p. 448–467, out 2008.</p>	<p>Taken into account. We added that CCS increases the cooling requirement with a reference to Zhai et al. Please note that the toxic emissions from amine-based CCS plants have been considered in the cited reference.</p>
3009	7					<p>An important issue very well documented in the literature is the tradeoff between oil products tighter specifications (especially for distillates and petrol) and GHG emissions from petroleum refineries (due to the increased fuel combustion and also the hydrogen requirements of hydrorefinery units). The section lacks this crucial discussion, which poses the challenges of matching energy security targets with high quality liquid fuels without increasing GHG emissions. Please see SZKLO, A. S., SCHAEFFER, R., 2007. Fuel specification, energy consumption and CO2 emission in oil refineries, Energy, 32(7): 1075-1092. JOHANSSON et alii. 2012. Assessment of strategies for CO2abatement in the European petroleum refining industry. Energy 42(1): 375-386. NORDRUM et alii 2011. Assessment of greenhouse gas mitigation options and costs for California Petroleum Industry facilities: The shape of things to come. Energy Procedia 4: 5729-5737.</p>	<p>Rejected. Please note that refining and transport are not addressed in Ch.7</p>
17939	7					<p>It might be a good idea for the reader to cross-reference other health-related impacts in other other chapters - particularly Chapters 8 and 9.</p>	<p>Noted.</p>
16848	7					<p>Listing the deaths associated with each source -- you need a timeframe please. Is it each year? The last 10 years? Since time began?</p>	<p>Editorial comment. This information is contained in the figure caption.</p>

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3010	7					<p>I do recognize that the safety record of nuclear energy has been relatively fine and Generation III reactors have enhanced safety features compared to the 1970s-era Generation II designs like those at the Fukushima Daiichi facility in Japan. In addition, as the section indicates, the number of fatalities from the nuclear energy system is far smaller than the number killed or injured, for example, producing energy from coal or hydropower. However, the manuscript seems to minimize the fact that:</p> <ol style="list-style-type: none"> <li>1. nuclear accidents pose threats for longer periods. Chernobyl nuclear power plant is now encased in a huge sarcophagus that will have to be maintained for hundreds of years to prevent radiation leakage.</li> <li>2. relicensing of existing nuclear plants beyond their design lifetimes increases vulnerability and risk: most of the current fleet of reactors are not and won't be from generation III or even III+. Hence, chances for another disaster grow.</li> <li>3. Finally, the long-term waste disposal problem has yet to be solved for nuclear power, and decommissioning costs are still highly uncertain. The minimum safety requirement for material leakage established by the US Environmental Protection Agency is 1 million years. This is a time very far beyond any possibility of social planning or even imagination. The manuscript, as it is, seems to compare the low social acceptability of nuclear with its low accident record, without acknowledging the reasons behind societies' preferences.</li> </ol>	Reject. Please note that we do not have the opportunity for a longer discussion of these issues. It is correct that lifetime extension of existing NPP are not addressed in this report as a mitigation option. We have noted explicitly, now in a table, that the waste issue needs to be resolved.
17941	7					Please consider a broader discussion of risks and uncertainties along the classification of risks and uncertainties provided in Section 6.7. Please liaise with the other sector chapter LAs to discuss the process by which a more consistent approach can be reached.	Rejected - space constraints do not allow to go into the details here.
11550	7					The focus on fatality in the context of risk is too narrow and the section is not systematic enough. Instead of focussing on number of fatalities from Chernobyl, authors may want to explain more comprehensively the risks associated with different technologies (e.g. CCS leakage, risks related to intermittency ->security, health hazards etc); distinguish between mortality and morbidity for humans; but also risks to humans, vs risks to broader environment, etc.	Rejected. The treatment of risk suggested here would be worthwhile but cannot be taken in the short space available here.
17942	7					The title of this sub-section is not consistent with agreements reached in Wellington (p. 36), by which it should be named: 'public perception'.	Accepted - we have made the change
17350	7		2		9	Discussion of public acceptability of new technologies is missin, unless it is expected that it will be in other chapters in which case it needs to give cross-reference. Also cross-reference to concepts like willingness to accept chapter 3.	Rejected - Not clear what other new energy supply technologies are being referred to here, as we include CCS, ocean, etc.
11866	7					It's not clear that this section really conveys particularly interesting information to the reader. Though it is interesting to consider trade-offs in local/regional electricity grids dependent on fossil fuels that may be imported, versus renewables that are local but not reliable on diurnal/seasonal cycles -this isn't really done in the section. Also, it seems to convolute issues of oil which (outside of oil-producing states where it may generate electricity) is really dominantly used for the transportation sector versus electricity grid reliability.	Rejected. The reviewer makes an interesting point. However, the suggestion made would require a lot more space than what is allocated in this section. Regarding the issue of oil, it is true that oil-importing states rely on the resource for electricity; but also many oil-importing developing countries also rely on oil for their electricity. West African region is a case in point

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12912	7					This section mainly focuses on the negative effects of bioenergy use. It would be appropriate to balance these negative effects with an up front description of the main beneficial effect, which is the replacement of fossil fuels. It is true that taking biomass out of forests can reduce carbon stocks and have a radiative forcing on climate. But the establishment of new forests may build up new carbon stocks and have a negative forcing on climate, see further comment 4.	Agreed. : sure, as long as we note that the assumption of 1:1 replacement is atheoretical.
12913	7					Again, the this section mainly focuses on the negative effects and criticism of bioenergy use. It would be appropriate to balance these with the main beneficial effect, which is the replacement of fossil fuels. As an example, in the section on Fossil fuel displacement (page 91, line 26-), 20 lines (26-47) are dedicated to describing why bioenergy does not fully displace fossil fuels, while only two lines (47-48) mention the important fact that this can be avoided by appropriate cap and pricing instruments.	Agreed. Need to be balanced. RICH: Felix, please explain to me how policy instruments affect global fuel market effects. I believe this is incorrect. All sectors have challenges in achieving efficient substitution of current CO2 intensive systems. We need to find sections to discuss challenges in designing efficient policies to this end in an orderly manner.
16879	7					Sustainable development -- I'm not aware of a formal definition of this concept -- are we talking about ecological systems, human systems, populations? Can we be more precise?	Rejected - comment seems to be misplaced. Please clarify to which part of the text your comment actually refers. 7.14 is about frequently asked questions.
3381	7	0				I have been supporting and contributing to the IPCC work for many years. It is therefore a great disappointment to read this FOD on this key chapter on Energy Systems. Huge differences exist between sections: from embarrassingly poor, superficial, rhetoric and badly written to excellent pieces of work. I do not know any of the authors and have no prejudices towards them, but I strongly feel some of them have done a very poor job for the IPCC in this FOD and should consider resignation (including, or in particular, any CLA responsible for the overall editing quality of this FOD). Some examples of clear flaws are included in this review. Other minor but also important points/questions have to be left for a SOD. CROSS REVIEW BETWEEN LAs HAS TO BE ENCOURAGED FOR THE SOD.	Noted - no operational suggestion is given here. The chapter has been improved considerably. A detailed cross review of the entire chapter has been carried out.
3382	7	0				It should be a very easy job to come down to 60 pages. Full subsections can be deleted because they repeat message better treated in other sections (see comments below). The number of references is huge and can be reduced by 1/2. Many of them are brought in to support obvious ideas or text with no new factual information. Also, when a major report by the IPCC, IEA, major database etc is referred to support certain data or piece of information, it is not be necessary to refer as well to a paper publication by an author or small group of authors (it may be even un-ethical if this reference is to your own group).	Noted - the reference list is not part of the page counting. The suggestion was taken into account where appropriate. We do acknowledge that the size has to be reduced.

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4428	7	0				The authors rely on IEA projections in the early part of the Chapter. Therefore, the Chapter reads more as a condensed IEA report and lacks the analysis and suggestions that we need to break the projected trends. The Chapter could be shortened by removing the background on oil reserves/resources on p23. The CCS discussion could be shortened and its nature as an end-of-pipe emphasized. That is, less use of carbon intense fuels means a decreased need for CCS facilities. The nuclear discussion could be shortened. The discussions on both nuclear and CCS are large disproportionately compared with the brief account of all other renewable energy sources. Similarly, the discussion on transporting natural gas and CO2 could be reduced.	Accepted - IEA projection has been removed from the early part of the chapter. The discussion of fossil reserves was shortened significantly. Rejected - CCS and nuclear play an important role in chapter 7 and therefore they have to be discussed in chapter 7. There has been a special IPCC report on renewable energies (RE) recently. The treatment of renewables energies therefore can be shorter than that of nuclear and CCS. Note that there is a biomass annex in chapter 11 in addition to the discussion of RE in our chapter. The necessity to reduce the length of the report is acknowledged, for example the sections on transporting natural gas and CO2 have been reduced.
12313	7	0				General comment: The use of SF6 in high-voltage appliances, such as gas insulated switchgears should also be covered in this chapter. Rationale: Use and, in particular, leakage of this long lived and highly potent GHG might be mitigated in a relatively cost-efficient manner. New infrastructure projects on electricity transmission are potential new sources of significant emissions of this GHG.	Rejected - the SF6 issue is a very specific one. Space constraints do not allow to go into all possible options for GHG mitigation in the energy sector
15353	7	0				Overall the document is comprehensive and has a good balance of pertinent climate change and energy issues pertaining to both developed and developing countries. A balance which is important for the global drive to combating as well as adapting to climate change.	Noted - a balance is indeed important.
16946	7	0				I regret I have not had time to review the Sectoral chapters in depth. My only overall comment on this chapter is that whilst the Sankey diagrams are technically very valuable, their complexity may risk obscuring simpler messages about the underlying structures of the energy system. A simpler classification and flow diagram - along with quantification of both energy and carbon associated with each main block - is offered in Chapter 3, of Grubb, Hourcade and Neuhoﬀ, Planetary Economics: the Three Domains of Sustainable Energy Development, Taylor & Francis forthcoming (Chapters 1 – 5 submitted, others in draft available on request). As it happens, our flow diagram pinpoints precisely the structure that follows in the next three IPCC chapters - namely that the energy system is driven primarily by the demands of transport, Buildings and Industry - and elaborates on some of the structural characteristics. Whether or not using a diagram like this, I do think that Chapter 7 should help to set this structural context and placement for the subsequent three chapters. □	Taken into account - a simplified graph now illustrates the relationship between the energy supply sector and the demand sector (see introduction).
9409	7	0				When summarizing findings in the IPCC AR4 and discussing effects of energy system or energy intensity improvement, it may be useful to review the following paper. Hanaoka, T. Kainuma, M., Matsuoka, Y. (2009) The Role of Energy Intensity Improvement in the AR4 GHG Stabilization Scenarios. Energy Efficiency, 2(2):95-108, DOI: 10.1007/s12053-009-9045-y	Taken into account - the comment is obsolete. The summary of the AR4 has been deleted due to space constraints.

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2819	7	0				<p>I have three general comments on balance/comprehensiveness (which are reflected in detailed comments below):</p> <ol style="list-style-type: none"> <li>1. Although the chapter is headed "Energy Systems" it gives insufficient attention to systems aspects. The largest part of the discussion is on low carbon resource availability and technologies – which is odd since, as the chapter acknowledges, this is not the main problem area. In my view, these sections (along with the scenarios section) could be shortened (including the discussion of bioenergy, which seems out of place here and should perhaps be relocated). Systems issues (such as infrastructure, investment, policies, institutions, regulation, market and pricing structures, systems operation and coordination, risk management and uncertainty etc) need more attention; demand in particular is inadequately treated. This may well be because some aspects of demand are discussed in other chapters, but the systems chapter is where things should be brought together.</li> <li>2. The choice of references seems to privilege academic (in both senses) sources over empirical analysis. For instance, scenarios and modelling results are often cited as though they had evidential value, even when there is (often conflicting) evidence available from the real world. The text does not set the scenarios in context or expose their sensitivity to the underlying assumptions. Most of the models assume a world of perfect foresight and no uncertainty and so fail to deal with some major issues affecting choices in the real world.</li> <li>3. In general, the discussion of specific issues is balanced. However, there are a number of points where the choice and treatment of sources seems selective. These are mostly relatively minor in themselves but they all point in much the same direction and leave an impression of bias in favour of certain options (renewables, CCS and carbon pricing) while other options are treated more neutrally (nuclear) or largely ignored (systems options).</li> </ol> <p>While none of these problems is fundamental, in combination they have the result that the scale and nature of the problem is mischaracterised and the responses are only partly analysed.</p>	<p>Taken into account - 1.) A new diagram in the introduction now clarifies the relationship between chapter 7 and the demand sectors. As chapter 7 is constrained to the energy supply part of the energy system, low carbon technologies must be discussed here in detail. Demand aspects are discussed in detail in the demand chapters. The discussion of general system issues has been improved throughout the chapter (especially in section 7.11). 2.) Rejected - the models used to derive the scenarios in section 7.11 are introduced and discussed together with their weaknesses in chapter 6. Space constraints do not allow to repeat the discussion in our chapter 3.) Taken into account - there is now a detailed discussion of the relative importance of the various options in section 7.11.</p>
15016	7	0				The impact of shale gas must be discussed somewhere in this chapter.	Accepted - The discussion of shale gas has been extended in sections 7.4.1 and 7.5.1.
15017	7	0				The discussion on the variation of CO2 emission factor from power generation will be useful to see the future reduction potential to electrification.	Taken into account - section 7.5.1. now provides a detailed discussion the CO2 reductions through better power plants.
4083	7	0				<p>The German Academy of Science (Leopoldina) recently issued a report named « Bioenergy, chances and limits », that can be downloaded here <a href="http://www.leopoldina.org/en/publications/detailview/?publication[publication]=433&amp;cHash=6828ed4387801f3c1e5ddaa5b636cf40">http://www.leopoldina.org/en/publications/detailview/?publication[publication]=433&amp;cHash=6828ed4387801f3c1e5ddaa5b636cf40</a> . This report is less optimistic than previous IPCC publications on bioenergy mitigation potential. IPCC figures on bioenergy should probably be re-considered with care, especially now that we have more insight on previous errors on biofuel carbon accounting (see here, for example <a href="http://www.guardian.co.uk/environment/2011/oct/07/european-biofuels-target-us-scientists">http://www.guardian.co.uk/environment/2011/oct/07/european-biofuels-target-us-scientists</a> ).</p>	Noted - bioenergy now has become an annex of chapter 11. The merits and shortcomings related to bioenergy usage are discussed there in detail.
11918	7	0				<p>Much space can be saved by removing redundancies, replacing text numbers with figures, and giving the text a good English edit. Also, order of text often does not seem logical. Why go from global markets (7.2.2) into Scale of GHG emission (7.2.3)?, especially in a section on Production, Conversion , and T&amp;D?</p>	Taken into account - text has been improved.

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18497	7	0				The presentation of mitigation options across the chapter is often inconsistent. This may only be limited to the order of technologies (e.g. in section 7.4 nuclear is presented before RE. In 7.5 this is reversed), but also varies quite substantially in the second half of the chapter (e.g. sometimes highlighting only one or two options, RE and CCS). Implementing a clear and consistent set of options (e.g. fuel switching, ee, RE, CCS, and nuclear) across sections 7.8, 7.9, 7.10 and 7.11 would be particularly useful to guide the reader.	Accepted - where it is feasible we discussed the options in the following sequence: fuel-switching, energy efficiency improvements, renewables, nuclear, CCS
9220	7	0				The chapter 7 is the bigger importance. The date, technology and economy information, and the sources used in this chapter is the bigger relevant The structure is well, but may be the chaptar can be shortened if Bioenergy Annex goes to Annex II Methods and Metrics. On the other ham, many titles of figures and tables includes some explanation that can send to foot page or the other place	Noted - the Bioenergy Annex was moved to another chapter.
2990	7	0				In all document shale oil must be distinguish from oil shale. "Shale oil" is also referred to as "tight oil", although they are not exactly the same thing. It is more important, however, not to confuse "shale oil" with "oil shale," as often occurs. Put simply, "shale and tight oil" are conventional oils (light oils with low sulfur content) trapped in unconventional formations, which make it extremely difficult to extract hydrocarbons. By contrast, "oil shale" is a precursor of oil called kerogen, a sort of teenage-oil that constitutes the building blocks of conventional oil. Oil shale is trapped in rocks with low porosity and permeability, making the extraction of kerogen difficult. However, the oil shale rocks are closer to the surface than those containing shale and tight oil. Thus, both the oil shale formations that contain kerogen and the kerogen itself are "unconventional."	Rejected - the usage of the terms is consistent with the scientific literature.
3006	7	0				In the manuscript, CCS was mainly analyzed for thermal power plant. However, different studies have shown that CCS will probably be applied in oil refineries too, mainly in hydrogen production units and FCC units. Please see Gomes, G.L., Szklo, A.S., Schaeffer, R., 2009. The impact of CO2 taxation on the configuration of new refineries: An application to Brazil. Energy Policy, 37, 5519–5529. de Mello, L., Pimenta, R. Moure, G., Pravia, O., Gerahart, L., Milios, P., Melien, T., 2009. A technical and economical evaluation of CO2 capture from FCC units. Energy Procedia 1 (1): 117-124. Kronberger, B., Johansson E., Löffler, G., Mattisson, T., Lyngfelt, A., Hofbauer, H., 2004. A Two-Compartment Fluidized Bed Reactor for CO2 Capture by Chemical-Looping Combustion, Chemical Engineering & Technology, 27 (12): 1318-1326. Miracca, I, Åsen, K., Assink, J., Coulter, C., Curran, L., Lowe, C., Moure, G., Schalsner, S., 2009. The CO2 Capture Project (CCP): Results from Phase II (2004-2009). Energy Procedia, 1 (1): 55-62. Castelo Branco, D.A., Szklo, A., Gomes, G., Borba, B.S.M.C., Schaeffer, R., 2011. Abatement costs of CO2 emissions in the Brazilian oil refining sector. Applied Energy, 88, 3782-3790. LINDSAY, I. et al. Designing a climate friendly hydrogen plant. Energy Procedia, n. 1, p. 4095-4102, 2009. MAHONY, L. CO2 capture for refineries, a practical approach. Energy Procedia, n. 1, p. 179-185. 2009.	Accepted - CCS can be applied to many different kinds of large stationary CO2 point sources. This point is explicitly made in the first paragraph of section 7.5.5.
3007	7	0				The manuscript lacks discussion on the important subject of gas venting and flaring. Please see the World Bank Programme related to that (TheWorld Bank Group. GGFR – Global Gas Flaring Reduction. Washington, DC:World Bank. See also: <a href="http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTOGMC/EXTGGFR/0,contentMDK:22137498~menuPK:3077311~pagePK:64168445~piPK:64168309~theSitePK:578069,00.html">http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTOGMC/EXTGGFR/0,contentMDK:22137498~menuPK:3077311~pagePK:64168445~piPK:64168309~theSitePK:578069,00.html</a> ; 2007); see also Castelo Branco et al. Co2e emissions abatement costs of reducing natural gas flaring in Brazil by investing in offshore GTL plants producing premium diesel. Energy 35 (2010) 158–167.	This is briefly mentioned in 7.5.1

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10041	7	0				This chapter lacks up to date information about the current development of the RE sector and focusses only on a very limited amount of scenario which are neither representative nor balanced. More informations of the previous IPCC report about Renewable energy (SRREN) must be incorporated. Currently the chapter is quite weak and too focused on IEA data, while the latest RE research results are not present.	Rejected - most of the discussion on IEA scenarios has been removed. The scenario results are based on a database which contains over 800 different scenarios of recent assessments.
3153	7	0				This chapter is so massively over limit it was almost impossible for me to review it. Delete the annex on bioenergy—why not just integrate it with the main text?	Taken into account - bioenergy annex has been moved to chapter 11. The size of chapter 7 has been reduced considerably.
4317	7	0	0	0	0	Wind power is now technically mature and it is not realistic to expect major reductions in cost apart from those following on from reductions in the cost of materials such as steel and material used to make the blades. Many manufacturers of wind turbines are no longer profitable and their share price is declining rapidly. (e.g Vestas) In the case of solar power, prices of solar cells are not likely to decrease much below \$1/Watt because, at this level, most manufacturers are losing money. The cost of mounting the cells, providing the cabling from the cells to the inverters, the cost of the inverters and transformers and the connection to the grid are all things that form the major part of the cost and are not likely to decrease substantially in the future. Many manufacturers of solar cells are no longer making a profit and their share prices are declining rapidly. Both industries are entirely dependent on a very large amount of subsidy. This subsidy is added to electricity prices so, in effect, the poor are subsidising the rich who are able to "Invest" in subsidised projects.. This is not sustainable. This section needs to be expanded to explain the situation.	Rejected - Many of these issues are adequately addressed in the present text, in our view. In fact, there are expectations for wind energy costs to continue to decline. We have seen substantial turbine advancements just in the last couple of years, primarily focused on reducing LCOE in lower wind speed sites. There are many expectations for this to continue. Similarly, solar modules today sell at ~70 cents/W (well below \$1/W), and the cost of production roughly matches this figure. While it is certainly true that both wind and solar manufacturers are currently operating on low margins, and in some cases negative margins, there is little indication that technological progress has ceased. Many industry watchers expect sub 50 cent/W modules in the next few years. Continued reduction in costs are especially possible if one considered non-hardware costs. In Germany, residential solar is installed at ~\$2.5/W; in the US that figure is above \$5/W - the difference comes in non-hardware costs. So even when hardware costs become static, there continue to be opportunities for overall cost reduction. As such, we simply do not agree that further cost reductions are unlikely. These industries do continue to receive incentives, as clearly acknowledged in the present text. Moreover, it is also clearly indicated that rapid deployments that may be called for under low-GHG targets will require greater policy intervention, and therefore cost increases. Whether these costs are

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4319	7	0	0	0	0	No one has been killed by the Fukushima accident and, because the radiation level experienced even by the workers at the site, was below the level that research has established as being dangerous, nobody will. (www.radiationandreason.com) In this respect, note that one dam failure in China (Banquo) ~26,000 people directly and many more from starvation. But the world did not stop building hydro schemes. I believe that, as the IPCC claims to be science-based, scientifically-based evidence like this should be pointed out.	Taken into account – Please note that there are many conflicting statements in the public about the risk of nuclear power and the consequences of the Fukushima accident. As a scientific body, the IPCC has to rely on peer-reviewed scientific publications. Utilizing research that has just become available, section 7.9.3 now includes following sentences: “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).”
4320	7	0	0	0	0	In many—if not most—countries renewable energy generates the maximum amount of power at times when the seasonal and daily electricity demand is not at a maximum. It is true that, at some expense, pumped hydro can compensate for daily fluctuations and batteries and other things can, at great expense, cater for shorter term fluctuations. However, there is no method available or on the horizon for storing large amounts of electricity for weeks or months. Pumped storage schemes have a daily cycle and have sufficient storage for 6 to 10 hours of full load operation. There are a few schemes with larger storage. In order to store large amounts of energy for long periods, a pumped storage hydropower scheme would have to have 2 huge lakes with 500 to 800 m elevation between them. It would also need a substantial water supply to make up evaporation losses. There are very few suitable sites available around the world and even fewer within reasonable distance of a large load centre. So there is no chance of storing surplus electricity from renewable energy sources for periods longer than a day or so. This single fact means that renewable energy cannot make a contribution to energy supply much over about 20%. Therefore, it cannot substitute for fossil fuel plants or nuclear power. The conclusion is that if there was a need to reduce carbon dioxide, nuclear power is the only large scale technology that we have. (Hydropower cannot provide large amounts of electricity in most countries.) Given the wind and solar power are much more expensive than nuclear, the pursuit of large-scale renewable energy is a mirage. (Note that countries that have more than 20% of renewable energy such as Denmark, export much of it at a low price to Scandinavia and Europe when the wind is blowing and blow it back at a much higher price when the wind is not blowing.) I think what I have written needs to be covered in the report. If it is not covered, then the thrust of the report is seriously misleading.	Rejected. Please note that the issue of grid integration and balancing is addressed in 7.6.1.
10440	7	0	0			There is an excessive of citations of IEA report, please expand your reference base	Accepted - the reference base has been extended.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10441	7	0	0			Why is the bioenergy in annex. This is very important and should be included in a chapter, eliminating some of the economic theory	Rejected - space constraints do not allow to go into the details of bioenergy in chapter 7. The annex has been moved to chapter 11 where space constraints are not as severe.
3634	7	0	0			Chapter 7 elaborates too much in CCS relative to other mitigation options, e.g. renewable energies. Chapter too much CO2-driven. Other GHG emission reduction potentials not sufficiently discussed.	Taken into account - other gases (e.g. fugitive methane emissions) are now treated in more detail. The discussion on CCS and nuclear is longer as there had been a recent IPCC special report on renewable energies.
4827	7	0	0	0	0	The chapter would profit from short summaries at the beginning and end of each section to help the reader remember the focus and main line of the chapter given how long the chapter is	Taken into account - a new introduction clarifies the content of the entire chapter. In various occasions, pointers to other sections are used to facilitate readability and understanding. However, due to space constraints, a summary of each section is not possible.
4828	7	0	0	0	0	The chapter should give more weight to affordability implications given the current economic crisis as this has an important impact on climate related policies.	Taken into account - sections 7.10.2 and 7.11 now contain a detailed discussion on investment needs.
17745	7	1				39 pages of references are far too many; several IEA reports are simply repetitive	Rejected- in order to provide a comprehensive assessment the underlying literature must be assessed. The page count do not take into account references.
6255	7	1				Energy in itself is not important to consumers. It's rather the services that energy delivers that matter. This is particularly relevant in discussions of risk, behavioural patterns and new investment. The interaction with consumers is currently lacking in the chapter, meaning that the context or the reality grounding the chapter is weak. In addition, the notion of behaviour related to market segmentation should also be considered in relation to customer centricity. A holistic view must be taken since the decarbonisation of electricity is the key to decarbonising other sectors (transport, domestic) which whilst reducing total overall emissions could cause increased emissions from the electricity sector	Taken into account - This is a problem with the entire report setup. The electrification is now addressed all the way in the scenario selection.
6256	7	1				there is a lack of distinction in the chapter between energy systems in developing countries and those in developed countries	Taken into consideration - a box on this distinction has been provided.
6257	7	1				Roadmaps from different sources are recommended for inclusion in the chapter, including the EU 2050 Roadmap, and scenarios from Eurelectric (Power Choices), EPRI (Prism) and Greenpeace.	Rejected - space constraints did not allow to include these scenarios in addition to the 800 scenarios of the scenario database.
6258	7	1				The diagrams must be much clearer. At present they detract from the text.	Accepted - almost all diagrams has been improved or changed.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6259	7	1				The language in the chapter is often inconsistent in its use of the terms energy, power, and electricity	Accepted - language usage has been improved.
6260	7	1				Additional sources of information should be used - suggested sources attached separately below	Taken into consideration - suggested sources have been reviewed and included when seen appropriate.
6261	7	1				<p>Withana, S., Núñez Ferrer, J., Medarova-Bergstrom, K., Volkery, A., and Gantioler, S. (2011) 'Mobilising private investment for climate change action in the EU: The role of new financial instruments', IEEP, London/Brussels.</p> <p>Behrens, A., Colijn, B., The Socio-Economic Transition towards Sustainability and its Impacts on Jobs in Europe, Intereconomics, Volume 47, Issue 3, May/June 2012, pg. 146-151, Springer, Berlin/Heidelberg.</p> <p>Behrens, A. et al., Escaping the Vicious Cycle of Poverty: Towards Universal Access to Energy in Developing Countries, CEPS Working Document, 2012.</p> <p>Teusch, J., Behrens, A., Egenhofer, C., The Benefits of Investing in Electricity Transmission – Lessons from Northern Europe, CEPS Special Report, 2012.</p> <p>Jul 2010 Behrens, A., The role of renewables in the interaction between climate change policy and energy security, Renewable Energy Law and Policy Review, Volume 1, Number 1, pg. 5-15, Lexion, Berlin.</p> <p>Behrens, A., The missing link: An integrated strategy to reduce greenhouse gas emissions from transport, in Notre Europe/Real Instituto Elcano/Egmont/GKI, Think Global Act European – The Contribution of 14 European Think Tanks to the Spanish, Belgian and Hungarian Trio Presidency of the European Union, 2010.</p> <p>Eskeland, G., Jochem, E., Neufeldt, H., Traber, T., Rive, N., Behrens, A., The Future of European Electricity: Choices before 2020, ADAM-CEPS Policy Brief, 2008.</p> <p>Giljum, S., Behrens, A., Hinterberger, F., Lutz, C., Meyer, B., Modelling Scenarios towards a Sustainable Use of Natural Resources in Europe, Environmental Science and Policy, Volume 11, Issue 3, pg. 204-216, Elsevier, Amsterdam, 2008.</p> <p>Fujiwara, N. 2012, 'Sector-specific activities as the driving force towards a low-carbon economy: From the Asia-Pacific Partnership to a global partnership', CEPS Policy Brief, No.262, January.</p> <p>Fujiwara, N., M. Alessi and A. Georgiev, 2012, 'Carbon market opportunities in Southern Mediterranean countries', MEDPRO Technical Report No.8, FP7, MEDPRO project, March 2012. NB: This report will be adapted and published in Carbon &amp; Climate Law Review, Special Issue on carbon markets and developing countries before November 2012.</p> <p>Fujiwara, N., and A. Georgiev, 2012, 'The EU Emissions Trading Scheme as a driver for future carbon markets', Report of a CEPS Task Force, March.</p> <p>Egenhofer, C., L. Milford, N. Fujiwara, T. L. Brewer, and M. Alessi, 2007, 'Low-carbon technologies in the post-Bali period: Accelerating their development and deployment', ECP Report No.4, European Climate Platform, December 2008</p> <p>Alessi, M &amp; C Egenhofer, Space Observation Systems: an underused asset in EU and global climate change policy. CEPS Policy Brief 245, 28 June 2011</p> <p>Núñez-Ferrer, J, C Egenhofer &amp; M Alessi, The SET-Plan: From concept to successful implementation, CEPS Task Force Report, April 2011</p> <p>Gros, D. &amp; C. Egenhofer, 'The case for taxing carbon at the border', Climate Policy, 11 (5), Special Issue, 2011</p>	Rejected. The relevance of these papers is not explained.
6247	7	1		135		In general, the draft is a long and tedious piece. The chapter is 100 pages, much longer than the 60 page goal; huge cuts will be needed.	Taken into account - the text has been reduced considerably.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6248	7	1		135		There is a huge amount of data, but little insight. The chapter never really gets around to saying anything. Many parts of the chapter read like a laundry list, naming a bunch of things and giving a few sentences of summary for each one.	Taken into account - the storyline has been improved.
6249	7	1		135		Many paragraphs appear to be comprised of many sentences, each put together by a different author. And many sentences appear to be crafted to encompass the full range of the data, often at the expense of communicating the central points.	Taken into consideration - Improved in SOD.
6251	7	1		135		this chapter would be more effective in communicating mitigation potential if it were organized more along the following lines:	Accepted - Responses done along the lines.
6252	7	1		135		1. Establish, using historical and current data, an account of the state of emissions from the power sector. I say power sector because that's actually all we're really interested in here; transportation is probably its own chapter. Nowhere in this chapter is oil mentioned except to say that oil-fired plants aren't very common.	Taken into account. It is not just power generation. It is also : heat generation, fossil fuels extraction, transport and distribution (See IPCC inventory guideline to energy sector boundaries.)
6253	7	1		135		2. Establish, using current research and development, the strategies available to mitigate emissions from the power sector. Strategies for mitigation can include technologies (CCS), economic measures (investments), and social programs (education). As the authors point out, no single strategy will work to fix this complex system.	Noted. Thank you. Those comments were kept in mind while developing SOD.
6254	7	1		135		3. Using research, forecasting, and data modeling, make an argument about the viability of methods and techniques to mitigate climate change outcomes.	Accepted - Those comments were kept in mind while developing SOD.
17390	7	1		135		I am afraid that I did not appreciate the tight timescale here (relative to my pre-existing commitments) and so read through the material very quickly. My reactions should be weighted accordingly.	Noted

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4638	7	1		96		<p>General comments on Chapter 7.</p> <p>First some background information. I have had over 40 years experience in renewable energy, especially biomass energy. I have worked in over 50 countries on biomass energy surveys, wood consumption/timber trends studies, renewable energy supply &amp; demand, biomass inventories and the environment. I have lived in Africa and Asia for 17 years.</p> <p>Some of my recent publications, which are pertinent to this chapter, are:                      Openshaw, K (2010a). Employment generation by biomass energy and its contribution to poverty alleviation in Malawi and other developing countries. Biomass and Bioenergy Journal 34, 2010. Elsevier, Oxford, England UK.                      Openshaw, K (2010b). Can biomass power development? Gatekeeper Series 144, April 2010. The International Institute for Environment and Development (IIED), London, England UK.                      Openshaw, K (2011a). Biomass as a benign energy source. Chapter 52 in Encyclopedia of Agrophysics. Eds. J. Glinski, H. Horabik, J. Lipiec. Springer.com/agrophysics. P.O. Box 17, 3300 AA Dordrecht, the Netherlands.                      Openshaw, K (2011b). Supply of woody biomass, especially in the tropics: is demand outstripping sustainable supply? The International Forestry Review, Vol. 13(4), 2011. Ed. A.J. Pottinger, the Crib, Dinchope, Craven Arms, Shropshire, SY7 9JJ UK. Published by the Commonwealth Forestry Association.                      Barnes D.F., Priti Kumar, Keith Openshaw (2012). Cleaner hearths, better homes: new stoves for India and the developing world. Oxford University Press. The World Bank. ESMAP (energy sector management assistance programme). ISBN 0-19-807836-6.                      Openshaw, K (2012). Remote sensing of biomass: principles and applications. Submitted for publication to the second sustainable world forum.</p> <p>Biomass energy is the only energy form that is treated in two ways, namely 'traditional' and 'modern'. This separation infers that 'traditional' biomass energy is non-sustainable and has to be substituted as quickly as possible for 'modern' biomass and other forms of renewable energy (RE). For example, P. 18 line 14 states that biomass and waste (demand) are growing at 2% per annum including traditional and modern ----. P. 57, line 8. "Providing clean, affordable and reliable modern energy services is also at the heart of development challenges in many developing countries ----". P. 57 line 12 "over 3 billion people are estimated to lack access to modern fuels for heating and cooking ----". P. 58 line 6 "The provision of access to clean, efficient, affordable and reliable energy services entails multiple co-benefits ----". Also, footnote 1 on page 9 talks about more comprehensive coverage of energy resources, including non-commercial ones (i.e. traditional ones).</p> <p>Granted unprocessed biomass has a lower energy value per unit weight and is more difficult to control than liquid and gaseous fuels. But charcoal is lumped with fuelwood, residues and dung as traditional. Charcoal is a processed smokeless biomass fuel that has an energy value on par or better than most coals and has never been 'non-commercial'. To denigrate some biomass as traditional, infers that the people using it are handicapped! In my opinion, there should be no distinction with types of biomass as inputs for different end uses.</p> <p>Chapter 7 keeps on mentioning energy access to modern fuels. But what it really means is access to electricity, for most people do have access to kerosene for cooking and lighting and many have access to LPG and even natural gas, especially in urban and peri-urban areas. However, for the rural population, if biomass is available within a reasonable collection area, most will use it in preference to fossil fuels. Kerosene is used sparingly. Space saving: Figure 7.1 top, can be deleted or the full Figure 7.1 can be deleted because the key numbers are in the text. The choice of categories reflect some prejudices in favour of geothermal: geothermal (0.06% of electricity) deserves a single colour/category, while wind (1.4% of electricity) is aggregated together with solar and mentioned only "after" solar. The same applies to Table 7.1: why "Geothermal, Solar etc" ? It is obvious from real numbers that it should be "Wind, Solar etc". Is this flaw also present in the IEA 2011 report used as a reference ??</p>	Noted
3384	7	10		12		<p>Space saving: Figure 7.1 top, can be deleted or the full Figure 7.1 can be deleted because the key numbers are in the text. The choice of categories reflect some prejudices in favour of geothermal: geothermal (0.06% of electricity) deserves a single colour/category, while wind (1.4% of electricity) is aggregated together with solar and mentioned only "after" solar. The same applies to Table 7.1: why "Geothermal, Solar etc" ? It is obvious from real numbers that it should be "Wind, Solar etc". Is this flaw also present in the IEA 2011 report used as a reference ??</p>	Disagree. This figure does illustrate very important point - that in last decade, fuel mix was evolving in favour of fossil fuels. It was modified in SOD.
4639	7	10		10		Percentage use. For 2009, solar, wind, etc. should be 0.5% not 0.0%.	Numbers were eliminated.
4640	7	10		10		Figure 7.1 Incremental growth in China. Between 1999 and 2010, biomass energy increased by about 25% or over 2% per year. No growth is shown in the graph. (Total growth increased 2.6 times).	There are no statistical sources supporting this statement. IEA reports no growth for 2000-2009.

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15942	7	10		10		why use 2009 data when 2010 data has been available for nearly a year...? And all such comparisons are invidious anyway, unless your energy source of choice happens to waste up to 2/3 of its energy as heat. I suggest you treat heat, transport and electricity separately.	Data was updated to 2010.
18502	7	10				It would be useful to have the same colors for the same technologies in the top and bottom panels.	Agree. We improved the design of figure 7.1
18503	7	10				Top panel: Having 2009 as an individual year to the left of a ten year increment beginning with 1991 is difficult to digest. It might be more useful to have an annual continuum from 1991 to 2009, rather than 10 year increments.	Not clear why. This section is mostly on evolution for the last decade.
18504	7	10				Lower panel: Note that it may be politically problematic to single out China in this graph, as there are no other individual countries highlighted.	China was removed from the figure and included in Asia.
10498	7	10				This is showing trends and is also referred to on page 18 - so suggest move from here to section 7.3.	The scale is presented by the table. This figure allows to see what energy sources drove energy use in different regions.
6174	7	10	12	11	2	This seems like one of the most important points to be made with respect to TPES – that supplying energy consumes more energy than anything else. Emphasize this point more strongly.	Text says "The energy supply sector is itself the largest energy user". So we think it is strong enough.
2991	7	10	12		16	Text is not clear: First, it is hard to understand the meaning of populated in the sentence. Second, the causality is spurious here: it is not true that a site that provides different energy vectors is more complex than one that is based on a highly-sophisticated and selective process to optimize one major fuel. This is easily seen in oil refineries. Hydroskimming refineries may provide different fuels (from fuel oil to petrol), while hycon refineries are able to optimize their outputs in a few high value added products.	The meaning relates to the table 7.1. The part of the table related to energy sector has less empty sells today as it was 10-20 years back.
17207	7	10	15			The text is misleading, since the conversion losses come with the production of higher value final energy carriers. This is especially the case for electricity, which is clean at the point of use and usually has a high marginal product.	Point is not taken. All energy is used to produce services we need. We do not need energy per se. So energy sector losses are just an energy price for higher quality energy. Text says name this.
12320	7	10	2			Please consider to add a figure (before figure 7.1) that shows energy consumption per source per region for 2009. This would complement the regional figure (second part of figure 7.1).	The task for figure 7.1 is to show what had happened in last decade. Adding new figures would be nice, but space limit does not allow for this
9632	7	10	2			the charts are confusing and the one legend for two charts is also confusing - consider labelling them a and b	We improved the design of figure 7.1
11917	7	10	2			Figure 7.1 is confusing. Are the "increments" added increments? Would perhaps show better as a line diagram.	We improved the design of figure 7.1
16120	7	10	39	13		These sentences seem to imply that curtailing some wind in part of the year is a "last resort" strategy. In reality, it can be much more economic or practical than new power lines or other flexibility improvements. For example this is official policy in Ireland. The sentences imply also we need synchronized implementation of flexibility measures, adding unnecessary burdens to an already complex path. Suggestion for the last sentence : "indeed curtailment of wind power is common practice where and when transmission constraints prevent full utilisation of available wind, [and increase of transport capacity may be suboptimal]."	There is no line 39 on this page.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9222	7	10	2	10	6	To integrate both Figures and send the "note" to foot page	We improved the design of the figure 7.1 where figures were integrated
10065	7	12				Instead of using the Header "Geothermal, Solar, etc." classify this as "Non-Combustible Renewables"	We use headings taken from the information source.
15015	7	12				Although these data are useful, but too much detailed.	Noted. The global energy balance is complex. This table shows end-use sectors by one line each and illustrate what energy carriers are needed for such sectors. It shows energy sector with more details to reflect the way energy resources are transformed to get other energy carriers.
10439	7	12				The entire table looks very similar to IEA world report tables, please change colors, orientations etc	It is more detailed than in IEA key world energy statistics. So colour scheme is close but slightly different.
10499	7	12				Change "bln kWh" to TWh. Need to explain why negative values in caption or footnote. Confusing as it is and needs greater explanation in the caption	Accepted - Negative numbers are explained in the footnote.
4429	7	12	14	12	15	Is the large room for efficiency improvement the difference between average efficiency and best practice or the difference between average/best practice efficiency and the thermodynamic upper limit (exergy) of the process?	Practically speaking between present and best available technology efficiencies. That is a regular way to assess the energy efficiency potential.
17383	7	124	1			S.C. Pryor and R.J. Barthelmie (2010): Climate change impacts on wind energy: A review. Renewable and Sustainable Energy Reviews 14 (2010), pp 430-437.	Rejected - This reference is included in the IPCC SRREN, which is the source document used for discussion of possible wind energy impacts. That meta-study includes this citations by reference.
17384	7	124	4			K. Rademaekers et al. (2011): Investment needs for future adaptation measures for EU nuclear power plants and other energy generation technologies due to effects of climate change - Final report. ECORYS Nederland BV, Nuclear Research & consultancy Group (NRG), Energy research Centre of the Netherlands (ECN), 2011.	Rejected - Good citations, but grey literature and not essential to support the points being made.
17385	7	124	4			<a href="http://ec.europa.eu/energy/nuclear/studies/doc/2011_03_eur24769-en.pdf">http://ec.europa.eu/energy/nuclear/studies/doc/2011_03_eur24769-en.pdf</a>	Rejected - Good citations, but grey literature and not essential to support the points being made.
3385	7	13				Several examples of unnecessary autoreferences (Rogner et al) when major international data bases and reports are used to support data. Do you need a reference to ( MIT 2011) in line 35 to support and obvious, school-text, sentence ? .	Taken into consideration. The references are needed to reflect the diversity of the literature.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
12587	7	13	1			The levels of waste heat from thermal power stations could be mentioned in context of total space heating demands, which I feel puts things in perspective. For example, in the UK the waste heat from thermal power stations is roughly equivalent to the total space heating demands in the UK. For evidence, please see <a href="http://www.decc.gov.uk/en/content/cms/statistics/publications/flow/flow.aspx">http://www.decc.gov.uk/en/content/cms/statistics/publications/flow/flow.aspx</a>	The heating sector is mentioned. CHP plants are reflected in the table. There are some limitations for their deployment based on heat demand and the discrepancy between power and heat load curves.
9633	7	13	1	13	7	The message in the first paragraph is not clear - hard to understand what is being said.	Accepted. The message was made clearer in the new first paragraph.
2823	7	13	1	13	3	The reference to "relatively low average global efficiency" is unclear. Relative to what? Efficiencies have been steadily increasing over time. If the reference is to some theoretical potential, citing only fossil sources is misleading; conversion efficiencies of renewable sources or nuclear are generally much lower (in terms of the amount of potentially available energy which they convert to useful work).	Relative to the best available technologies. See paragraph below.
11846	7	13	1	13	7	This paragraph is quite confusing, particularly lines 4 through 7. It seems quite clear that converting primary energy into energy carriers is inefficient - but it is not clear what this paragraph is saying beyond that - what is meant by "large own energy use in energy sector," for example? If it simply means it takes energy to make energy, and on average a lot of energy is lost as waste heat, it seems like this can be said simply and concisely. This is one of many spots in the chapter where text can be eliminated without losing content.	Disagree. It is not that simple. Energy transformation technologies require energy and bring some losses. Both are substantial. Some comments stress importance of this message (see comment 13454).
5943	7	13	1	21		There is an issue of objectivity (use of language which could be considered pejorative) which does not reflect the age of investments and economic factors	There is no such flavour in those paragraphs. They just fix present low efficiencies and potential for improvement, not blaming anyone.
16782	7	13	1		32	Could be significantly shortened. No context, not particularly useful in terms application or policy formation.	Some cuts were made. It brings present status picture as a departure point for the following discussion
16783	7	13	1		7	These numbers do not address the "quality" or usefulness of the energy -- the more relevant metric to discuss is the delivered cost of the useful energy.	The issue of energy costs is dealt with later in the chapter. Here only the energy balance is discussed
6226	7	13	12	13	15	Mention should be made of thermodynamic limitations on efficiency (Carnot/Kalina cycles)	Rejected - the thermodynamic limits are of limited use as long as the temperature conditions are not fixed. In addition, fuel cells might use fossil fuels with a theoretically much higher efficiency.
16784	7	13	12		15	The implication is that there are large improvement opportunities possible, but these are only really true if we build completely new plants -- most can not be modified to produce these efficiencies. Do you want to leave reader with impression that modification can do the job or that we might just build new plants and that will help when building a new plant with only slightly better tech will lock in emissions for 40 years?	Those issues on what technically is possible and by when are dealt with later in the chapter. This is just an introduction to those sections.
2992	7	13	14			It is not true that gas fired plant efficiency is only related to best practices. It depends on the environment conditions of the operation (temperature and pressure) and also it depends on the integration of these plants into the power grid.	There are many factors like capacity load and others. The comparison is made keeping other factors equal.

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16785	7	13	15		21	It is not clear to me what the point is of citing thermal efficiency numbers without any context. How is this meaningful to the issue at hand?	Those issues on what technically is possible and by when are dealt with later in the chapter. This is just an introduction to those sections.
16786	7	13	22			Suggest perhaps that you qualify statement by inserting at start of sentence: "In some cases," -- the statement as it stands now is not a universal condition.	There is "often" in this sentence to reflect this concern.
4102	7	13	25	13	25	Here, and at many other points, the 'Global Energy Assessment' is referenced as 2011. As of September 5, 2012, I await my copy from Cambridge University Press as a reviewer.	Noted. The correct reference details of the GEA were updated.
9634	7	13	26	13	27	Please clarify - is this 82% of what is used by industry, not including electricity generators?	The final use means that all energy transformation sectors are excluded. It is covered by glossary.
5151	7	13	26	13	26	what is the intent of this sentence?	Intent is to show what sector demands what energy, which energy supply sector should deliver.
10500	7	13	3			Does the 37% include T&D? References needed in this para.	It is for power generation as it is written.
5948	7	13	33			Section 7.2.2 does not describe energy markets per se (rather it describes traded volumes). It is not clear what the value of this section is. A more relevant aspect may be to highlight the differences in fuel prices between regions and its influence on demand	Taken into account - text has been shortened. Space constraints do not allow to go into the details of price differences.
16788	7	13	33		37	This seems to imply that trade creates more problems than benefits -- evidence suggest this is not true. The problem is not trade, but end use efficiency and energy technologies.	Taken into account. The text was reformulated to avoid this impression.
16787	7	13	33	15	4	This section could be significantly shortened and still make the useful points. The usefulness of this section is not clear -- if wish to discuss problems of oil dependence, perhaps ref peer reviewed lit exploring links of energy prices volatility as trigger for economic recessions or something of this nature. You should check how well this is regarded in economics profession, but you might begin with Oil Price Uncertainty by Elder and Serletis in the Journal of Money, Credit and Banking.	Taken into account. The inclusion of this section is agreed by authors to be important to bring the message of regional variations in the development of technologies. The section has been significantly shortened.
5944	7	13	34	37		The paragraph lacks clarity. Is international trade being presented as a risk or opportunity? What is the role of markets?	Taken into account - comment is obsolete. Underlying text has been deleted.
6418	7	13	36	13	36	I suggest using a word other than "price". It implies financial issues, but here it is being used more as "the expense of"	Accepted. The editing replaced it by "at the expense of" as suggested by the reviewer.
10502	7	13	5			Footnote 2. .... of "the" direct equivalent method, "as used here, gives lower losses."	If power generation efficiency is just 37% that means losses are 63%. For CHPs losses are 41%. Why you think that 50% are too high? There is no room for additional figure.
17361	7	13	6			high potential indirect multiplication effects...	Accepted - It has been fixed.
6175	7	13	8	13	21	No need to summarize the chart so directly. The large number of detailed staistics actually impairs comprehension. Instead, highlight the numbers that are striking, unexpected, or relate to future arguments and ideas.	Some text which repeated the table data was eliminated. Paragraph on low heat and power generation efficiencies are later dealt with in the chapter.

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15943	7	13	8	13	12	Why use 2009 data, when 2011 data is available for RE sources, at least, although it may have been published just after this draft was prepared, i.e., July 2012 - see IEA 'Renewables Mid-Term Market Report' which has production numbers for RE sources for 2011 <a href="http://www.iea.org/w/bookshop/add.aspx?id=432">http://www.iea.org/w/bookshop/add.aspx?id=432</a>	Data was updated.
13288	7	13	9	13	21	When citing conversion efficiencies, it should be clear whether they are on a gross or net calorific value basis (also known as higher / lower heating value) - this makes a difference of around 5 % points, which is pretty significant	Rejected. The title of table 7.1 says that.
10501	7	13	9			with "total" generation losses. These data could be more clearly shown in a pie chart figure. 28.7% plus 4.4% = 33.1% of TPES has losses of 16.7% of TPES - meaning there are around 50% losses. Seems high but maybe not. See TS Fig 8.2 of the SRREN for graphical representation.	If power generation efficiency is just 37% that means losses are 63%. For CHPs losses are 41%. Why you think that 50% are too high? There is no room for additional figure.
13454	7	13	6	13	7	Text: "Those low efficiencies and large own energy use in energy sector result in a high potential indirect multiplication effects of energy savings from end users" This point cannot be stressed enough - reducing final end point consumption has a more-than-equivalent impact on energy waste at all stages in the energy supply chain - it can even remove the need for replacement energy plant on lifecycle turnover, in some cases.	Noted.
17386	7	131	19			R. Vautard et al. (2010): Northern hemisphere stilling partly attributed to an increase in surface roughness. Nature Geoscience Letters, 17 October 2010.	Rejected - Good citation, but cannot easily place this within the quote
17746	7	135				there should be a page of FAQ	Taken into consideration. FAQs are now presented through boxes in the text.
15542	7	14	1			Increased trade should reduce the volatility of prices	Taken into account - comment is obsolete. Underlying text has been deleted.
5945	7	14	1	3		Ditto	Please clarify what you mean.
17215	7	14	16			In the list of countries the US is missing.	Taken into consideration. The text has been updated.
5947	7	14	17	19		Clarity lacking. What is the intent of this statement?	Rejected - the sentence is based on a citation.
16033	7	14	17	14	19	to much sources	Rejected. Not harmful to have many sources
6419	7	14	20	14	20	Without policy limiting CO2 emissions, natural gas does not penetrate due to its low CO2 emissions relative to coal. As written, this sentence implies that it does. It penetrates because of its high energy density, transportability, and fungibility for end-uses... not because it burns efficiently.	Accepted. The sentence has been deleted.
12321	7	14	20	14	21	Market penetration depends on pricing - not GHG emissions. However, lower GHG emissions gives natural gas a competitive advantage in markets with CO2 pricing. Please consider to reflect this fact.	Taken into consideration. The text has been deleted.
13289	7	14	20	14	20	The combustion GHG emissions from natural gas are not 'low' as stated, merely lower than coal and oil - suggest replacing with 'relatively low'	Agreed. The text has been modified.
18045	7	14	20	14	20	Replace "low" with "lower GHG emissions than coal". The term "low" is very subjective and ambiguous.	Agreed. The text has been modified.
16789	7	14	20		34	The beginning of the paragraph suggest that transport of nat gas is expensive -- this is not universally true -- pipeline transport can be relatively inexpensive and exists in several places as you note later in paragraph.	Rejected - for most countries this is the case.
2824	7	14	23			This overstates the regional nature of gas markets. There is significant inter-regional trade and some inter-regional price transmission so it is not true that markets are limited to regional scales, though of course the regional markets do all have different characteristics.	True but don't see relation with the lines quoted
7119	7	14	27			"...reached 32% with special concern for almost 650 mln." Missing units after 650 million.	Accepted - text revised.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9635	7	14	35	14	42	Include that: Coal was only to renewables as the fastest growing fuel in 2011 (BP, 2012)	Rejected - the text discusses the different fuels and sources in sequence not in comparison.
2825	7	14	35			While it is often claimed that coal is widely distributed, the claim appears to have no foundation. Occurrences of coal are of course widespread, but that is true of other fossil fuels and not of any particular significance. In terms of proved reserves, BP lists 55 countries with natural gas reserves, of which the largest has 23.7% of the global total; for coal the equivalent numbers are 33 and 28.9%. Production of coal is even more concentrated (the largest coal producer, China, accounts for 45.6% of the world total while the largest gas producer, the US accounts for only 20%), as is trade.	Rejected - the text discusses the different fuels and sources in sequence not in comparison.
16790	7	14	35		42	You may want to include point that export of coal from North America is increasing as lower coal demand (from competition with cheap natural gas) is dropping prices, making North American coal competitive on the global market.	Taken into account - the US now are mentioned as a big producer
11847	7	14	36	14	37	Please tell the reader the top importing countries - it is strange that the top exporting country is listed (Australia) but that importing countries are not identified.	Taken into account - comment obsolete. Underlying text has been deleted.
5946	7	14	4	8		Clarity lacking. The global oil market is not driven primarily by fuel transportation costs	Taken into account - it is now driven, but it is facilitated.
10503	7	14	40			Here and elsewhere needs past tense	Accepted. "Was" used instead of "is"
9468	7	14	43	15	1	I have a doubt about the description that trend for uranium production to expand is challenged recently by the Germany's decision to phase out its nuclear program and Fukushima accident, as in many countries other than Germany and some countries there are movements of building new and additional nuclear facilities, from the standpoint of energy security. In September 2011, J. Steyn and T. Meade published an article in Nuclear Engineering International about the uranium supply capacity and requirements in the world after the Fukushima accident [1]. It concludes that "One repercussion of the recent events at Fukushima Daiichi in Japan was an immediate drop in uranium requirements in Japan and Germany. But, over the long term, uranium requirements are expected to grow steadily." They note that it is clear from the data, that current mine capacity and capacity under development, plus total already mined uranium (AMU), are projected to be adequate to meet reference requirements through the early 2020s. They also note that if needed, projected supply can be augmented by prospective mine capacity, of which there is a significant amount. [1]J. Steyn and T. Meade (2011) "Demand down, for now," Nuclear Engineering International, September 2011, pp. 22-26 See online article at <a href="http://www.neimagazine.com/story.asp?storyCode=2060839">http://www.neimagazine.com/story.asp?storyCode=2060839</a>	Taken into account - comment is obsolete. Underlying text has been deleted.
6420	7	14	43	14	43	"About 433" is quite specific. If it is 433, then that should simply be stated. Or perhaps something like, "Approximately 430"	Agree, editing. "About" has been deleted.
18200	7	14	43		47	Add to paragraph: About 433 nuclear reactors worldwide require annually 77,000 t of uranium oxide concentrate (U3O8). Uranium mines supply about 60,000 t of U3O8 with the rest supplemented by secondary supplies from ex-military materials and other inventories (World Nuclear Association, 2011). Trend for uranium production to expand by 52% observed in 20002010 is challenged recently by the Germany's decision to phase out its nuclear program by 2022 and the Fukushima major accident in Japan. The number of uranium exporters is limited to a few countries - Kazakhstan, Uzbekistan, Namibia, Niger and to a lesser extent South Africa, as well as Australia and Canada ((World Nuclear Association, 2011). Markets for other energy carriers (combustible biomass, waste, electricity, and heat) are mostly domestic, because they don't need any with very limited amounts of cross-border trade (Table 7.1).	Taken into account - comment is obsolete. Underlying text has been deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18201	7	14	43		47	About 433 nuclear reactors worldwide require annually 77,000 t of uranium oxide concentrate (U3O8). Uranium mines supply about 60,000 t of U3O8 with the rest supplemented by secondary supplies from exminitary materials and other inventories (World Nuclear Association, 2011). Trend for uranium production to expand by 52% observed in 2000-2010 is challenged recently by the Germany's decision to phase out its nuclear program by 2022 and the Fukushima major accident in Japan. The number of uranium exporters is limited to a few countries - Kazakhstan, Uzbekistan, Namibia, Niger and to a lesser extent South Africa, as well as Australia and Canada ((World Nuclear Association, 2011). Markets for other energy carriers (combustible biomass, waste, electricity, and heat) are mostly domestic, because they don't need any crossborder trade (Table 7.1).	Taken into account - comment is obsolete. Underlying text has been deleted.
5926	7	14	43	44	1	Suitable references to nuclear policies after Fukushima are: 1. Globally: P. Joskow, J. E. Parsons, The Future of Nuclear Power After Fukushima, Econ Ener Env Pol 1(2) (2012) 99-113, and 2. Concerning EU countries: Syri S., Kurki-Suonio T., Satka V., Cross S., Nuclear power at the crossroads of liberalised electricity markets and CO2 mitigation - case Finland. Energy Strategy Reviews (accepted with minor rev.) Concerning the EU, all Eastern European MS still see nuclear power as viable option, whereas mainly Germany, Italy and Switzerland have chosen to abandon nuclear power (production/ plans).	Taken into account - comment is obsolete. Underlying text has been deleted.
9503	7	14	45	15	4	This texts may cause the misunderstanding of the uranium supply shortage, and should be deleted. Because the supply of uranium have been enough, and effects for the uranium supply by the Germany's decision and Fukushima accident are temporary. Smallness of the number of supply country cause no problem.	Taken into account - comment is obsolete. Underlying text has been deleted.
16034	7	14	47			Germanys and Japons decission to phase out there nuclear programs (2022, 2030th years)	Noted.
9223	7	14	10	14	10	Delete "Figure 7.1") because in Figure 7.1 can see this detail	Accepted. The figure has been deleted.
13456	7	14	20	14	23	Text: "Natural gas penetrates many markets because it burns efficiently with low GHG emissions, and requires limited processing to prepare for end use. But it is disadvantaged in terms of transmission and storage, because of its low energy density, which makes transportation costs a large fraction of the total supply chain costs. This limits the development of gas markets to regional scales." Gas fuels are likely to become increasingly sought after for a number of reasons, including low combustion carbon emissions, and oil supply questions. This makes it imperative for gas capture, storage and distribution networks to rise up the agenda, for both climate change and energy security reasons. It may be that gas prices will need to rise to accommodate these extra costs.	Agree with addendum but issue of space
3448	7	14	35	14	42	It should be mention the importance of USA in the coal consumption worldwide	Taken into account - the US are now mentioned as a large coal producer.
13457	7	14	39	14	42	Text: "Australia dominated the list of coal exporters (IEA, 2011a). China is responsible for nearly 90% of additional global coal use in 2000-2009 (Figure 7.1). India also plays an increasingly important role. Power generation remains the main driver of global coal demand (US DOE, 2011a)." With the disruption in the global economy, it is possible that China will not be able to keep up its current rate of economic growth as its trading partners have worsening deficits.	Rejected - the section is about historic trends not future expectations.
13455	7	14	6	14	8	Text: "Most prominent oil supply security concerns relate to over 3 bln. people living in 83 countries (including all of the world's low-income countries) importing more than 75% of the oil and petroleum products they consume." It is critical that the issue of energy access be addressed, because many of the countries dependent on energy imports are at risk of paying ever-increasing prices for those energy supplies. Some countries are consistently in GDP deficit over energy imports, and a worsening situation, either in terms of fuel scarcity, or fuel cost increases, will lead to these countries being unable to achieve development goals.	Agree with addendum but issue of space constraints.
7118	7	14	7			"relate to over 3 bln". Missing units after 3 billion	Accepted - text revised.

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3386	7	15				Section 7.2.3 should be rewritten. Explain clearly what sectors are included in the "Energy related GHG emissions" (Energy sector, transport, industry, buildings... to add 100%), and make figure 2 consistent with the text (at present it is not using the same categories mentioned in the text (around line 17).	Taken into account. The section has been deleted.
3449	7	15		15		Include in this figure the total amount of GHG emissions	Taken into account. The section has been deleted.
6796	7	15				This is a useful figure, although there is a lot of uncertainty in some of these numbers, such as the Chinese emissions. The problem with this graph is that many readers will interpret this to mean that China is the biggest cause of climate change. It would be better if you also included a graph showing the accumulated energy emissions to date of the various countries. It is the sum of all the added CO2 to the atmosphere since pre-industrial times that causes climate change. Absent an additional figure, the text (and, perhaps the figure caption itself) should provide some explanation.	Taken into account. The section has been deleted.
6177	7	15				The coloring here renders this chart difficult to read. Suggest using more contrasting colors and/or patterns.	Taken into account. The section has been deleted.
5152	7	15		15		unclear - is it meant that the 33028 comes from the energy sector and the rest do not ?	Taken into account. The section has been deleted.
10506	7	15				Could leave transport and industry CO2 data in the pie chart and not in the box which then really becomes an "energy sector" box. CO2 "other" I assume is deforestation - so why not call it that - also CH4 and N2O "other" are maybe mainly Agriculture	Taken into account. The section has been deleted.
10507	7	15				Does top graph include transport emissions too? Another example of where the chapter boundaries are unclear.	Taken into account. The section has been deleted.
4103	7	15	1	15	3	Although thorium is mentioned later (p. 24) this would be an appropriate place to mention thorium also.	Rejected - space constraints do not allow to go into the details here.
6227	7	15	11	15	11	Coal combustion does not produce Nitrous oxide (N2O) emissions but does produce Nitric oxide (NO) & Nitrogen dioxide (NO2) emissions which have different GWPs	Taken into account. The section has been deleted.
10505	7	15	17			Can add chapter numbers 8,9 and 10 here	Taken into account. The section has been deleted.
2969	7	15	18			In the legend it is written "energy sector" but it should probably be "power sector" as in figure 7.3. This is in line with the previous comment.	Taken into account. The section has been deleted.
12323	7	15	18			Please improve the colour coding/caption as it does not seem to be coherent. It is also difficult to see how this ties with the percentages given in the text above.	Taken into account. The section has been deleted.
17214	7	15	23			The CLAs may want to discuss the issue of national CO2 statistics and the global aggregate here.	Taken into account. The section has been deleted.
13291	7	15	23	15	24	Where this says 'As is the case with energy...' it should probably say 'energy consumption'	Taken into account. The section has been deleted.
16791	7	15	23			Rather than a disagreement, could it perhaps be a range of values or estimates?	Taken into account. The section has been deleted.
10504	7	15	4			Table 7.1 doesn't show this as is stated in the text.	Taken into account. The section has been deleted.
13290	7	15	5	15	17	As per the first sentence of the Executive Summary, it is essential to define here what you mean by the 'energy sector' (presumably heat and power generation) - otherwise this section is very confusing	Taken into account. The section has been deleted.
12322	7	15	6	15	9	Please define what is included in the energy sector. It is also unclear what percentage of emissions are the result of fugitive methane emissions etc. Please consider to include this and rephrase.	Taken into account. The section has been deleted.
6176	7	15	6	15	6	See comment #1. The "energy sector" would be less confusing if it were renamed as "the energy supply sector".	This name is set in IPCC Inventory Guidelines. There it is called energy industries. A new figure in section 7.1 clarifies the system boundaries.

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18505	7	15				This section can be shortened substantially (e.g. removing much of figures 7.2 and 7.3) by referring to the discussions in Chapter 5, which provide overarching information on emission trends across sectors. This section should focus more strictly on energy.	Taken into account. The section has been deleted.
9224	7	15	18	15	21	To improve the legend,it is very confuse	Taken into account. The section has been deleted.
3387	7	16				Consider deleting paragraph and even the Figure 7.3-top as there is no statistical correlation to report beyond what the numbers stata in Figure 7.3-bottom.	Taken into account. The section has been deleted.
16095	7	16				The trend as drawn is not very convincing	Taken into account. The section has been deleted.
6178	7	16	1	16	2	References to large ranges of variability, expressed here as 1-99%, are not improved by adding numbers to such an open-ended range.	Taken into account. The section has been deleted.
5949	7	16	3	4		Lacks clarity. It is not clear wht the purpose of including the analysis in this paragraph is other than to say that the extent of the agriculture and forestry sector in each country determines where the upper bound on the contribution of energy related emissions lies.	Taken into account. The section has been deleted.
3777	7	16	4	16	6	"the energy sector emissions contribute more than 60% to total national GHG emissions. I understand this doesn't apply to all countries. See as example, Brazil.	Taken into account. The section has been deleted.
3778	7	16	6	16	7	Power generation dominates emission in all 15 major emitting countries. I understand this is not the case for Brazil.	Noted. Right, Brazil is an exception. This figure was removed.
9636	7	16	7			Label charts a and b	Taken into account. The section has been deleted.
4641	7	17		17		. Difficult to follow. Bar column colors not explained.	See legend in low left corner.
3388	7	17	1	22	8	Is this section necessary in view of other chapters dealing in more detail with the same issues?. In particular: section 7.3.3 is too small, generic, superfluous and somehow rethoric if the topic is treated just in this subsection. It unnecessary here, as this important issue is treated somewhere else in the AR.	This introductory part of the chapter shows the present status in energy sector. Section 7.3.3 was removed
3154	7	17	1			Section 7.3 overlaps with other drivers discussion. Should all this be done in chapters 4 or 5?	Those two chapters provide much material on drivers. In energy supply chapter there is only brief discussion on drivers to follow approved by IPCC outline and to set a stage for the following discussion.
9637	7	17	14	17	14	Reference for slower population growth - is this global population growth?	It is on p. 16. Yes, it is global.
17362	7	17	17			evolution was much...	Editorial.
9638	7	17	25		29	Energy demand grew and CO2 emissions increased in spite of efficiency improvements, owing to the electrification programme in China	Noted. It is not clear what LAs are requested to do.
6179	7	17	25	17	26	"Rates of global energy intensity decline were not sufficient to compensate for GDP growth, thus leaving room for energy demand to expand." As phrased, this suggest that growth in energy demand found an opportunity, when as described it was a tautological outcome. Rephrase as "Rates of global energy intensity decline were not sufficient to compensate for GDP growth, thus energy demand inevitably expanded."	The suggested phase express the inevitability of energy demand growth. First, we do not meant this, second, it is not simply true (see fig. 7.1).
6446	7	17	25	17	26	This sentence refers to the rebound effect and I suggest mentioning rebound effect at this point.	There is no text on rebound effects in this section. This is an issue mostly for final use sectors which are dealt with following chapters

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11919	7	17	25			This sentence can be dropped - it does not add anything and is confusing in any case, i.e., energy demand can arise for a number of reasons, not just intensity decline.	Disagree. This sentence does not say this. It just say that EE progress was not sufficient to compensate for economic activity growth globally, while in some regions it did compensated and there were no energy demand increase in last decade (see fig. 7.1)
11920	7	17	26			Begin with "Energy demand growth"	The phrase is wider and we prefer to keep it as it is. The chapter is on energy supply mostly. See section subheading.
5950	7	17	4			Is there evidence to support the statement that natural resource availability is a factor in influencing the growth in energy supply and demand?	Text says "for energy demand and supply". It is hard to argue against that resources availability is a key driver for energy supply.
4807	7	17	4	17	4	"Major drivers for energy demand and supply" you should mention demand drivers first and they supply drivers	They are different. Supply drivers include also resources availability.
13458	7	17	10	17	13	Text: "The interplay between the drivers in 2001-2010 was very different from that in the previous decades (Figure 7.4). Global total primary energy supply (TPES) expanded by 27%, or by 2.4% per annum (2% in 2011), which is much faster, than in 1980-2000, when energy prices were significantly lower." The globalisation of trade has been a major economic goal of the World Trade Organisation and other bodies. It is logical that when industry relocates to countries where there is little infrastructure, that solid fuels are the choice for the power generation that manufacturing needs. In order to lessen the carbon intensity of globalised production, it is necessary to provide more sophisticated energy systems, through technology transfer, and through the building of grids, storage and plant needed to operate more carbon-efficient electricity and gas systems.	All those issues are covered by chapter 7 in following sections.
9225	7	17	22	17	22	Add "Note" after (2011 a)	This is IEA data. See note to the figure 7.4
13459	7	17	25	17	26	Text: "Rates of global energy intensity decline were not sufficient to compensate for GDP growth, thus leaving room for energy demand to expand" China, for example, is attempting to initiate strong renewable energy growth, whilst at the same time continuing with policies for strong economic growth. As in more developed countries, renewable energy sector growth is slower than fossil fuel use growth.	Taken into account - comment is obsolete. Underlying text has been deleted.
13460	7	17	27	17	29	Text: "Global energy consumption per capita after stabilization in 1991-2000 started growing as fast as it was back in 1971-1980." This partly reflects an economic shift - energy-intensive manufacturing was transferred, under globalisation policy, from energy-efficient economies to energy-inefficient economies.	It mostly reflects the growing share of China and India in global energy use and growing per capita consumption in those countries.
6180	7	18	1	17	1	"The slow trend to diversification of energy sources away of fossil fuels was blocked in last decade." is misleading. As worded, this sounds as if there was an active thwarting of policy, when several other explanations are possible. Suggest rephrasing as "The trend to diversification of energy sources away from fossil fuels slowed in last decade."	Taken into account - comment is obsolete. Underlying text has been deleted.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16792	7	18	1		18	May be able to delete this section -- or significantly shorten and replace with ref to IEA pubs, or replace with a graph.	Disagree. This is the only section on recent trends in energy supply in energy supply chapter. Trends for primary energy sources are described in very concise manner.
16096	7	18	17	18	18	This association of RE and nuclear is misleading also because the development and decline of nuclear was associated in the US or in France by an increase of costs (see Grubler A. 2010 "The costs of the French nuclear scale-up: A case of negative learning by doing, Energy Policy 38 (2010) 5174–5188 ). RE is also much more market driven with many actors, when states dominated the process of nuclear expansion.	This phrase is only on the fast development of the RE contribution, but not on the whole cycle to its evolution.
10509	7	18	17			Not Fig 7.4 - not clear which figure it refers to	Taken into account - comment is obsolete. Underlying text has been deleted.
3155	7	18	19			I would keep figures 7.5 and 7.6 and pare back the rest	Figures were modified or replaced.
6421	7	18	26	18	30	"was marked by the failure to decarbonize the global fuel mix" is a very strong statement, and I doubt that anyone expected to decarbonize in a decade. Figure 7.5 shows CO2 emissions, and nothing about policy. There needs to be support for the statement about "strongest ever carbon emission mitigation policies"	Accepted. Text revised: Failure to do progress in decarbonizing.
4430	7	18	26	18	30	Could this irony be attributed to policies which promote low gCO2/kWh instead of low gCO2 absolute? It is the issue of normalized measures concealing the real trends (illustrated in Fig 7.4). Indeed, climate change is affected by absolute amounts of CO2, even if we become more efficient at extracting energy services per mass CO2.	Very good guess. Irony was initially in the text, but then was removed through editorial process. The commitments for many countries are expressed in absolute reductions or reductions compared to BAU, not in reductions per 1 kWh.
4104	7	18	26	18	30	The impacts, causes and sources of 'embedded emissions' should also be mentioned here.	Chapter 5 deals with this issue. There are grounds to speak on this subject in this paragraph.
6181	7	18	26	18	30	The comment that the last decade has seen both the highest growth in emissions and the greatest political will to curb them seems really critical to the story being told here. it would be valuable to unpack why this might be – where is the increase coming from? Is this unique to the energy sector?	Agree. New figures 7.3-7.4 provide visual images for causes with accompanied some text. They all show the origins for increase both by sectors and by regions as well as differences in evolution.
10508	7	18	4			Is this OECD demand for transport or for oil? - ambiguous as written. If oil, it has declined due to lower demand for heating oil - maybe worth clarifying.	The statement is correct. The OECD oil consumption by transport both in 2009 and 2010 was below 2000 level.

**Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7**

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6797	7	18	5	18	6	When mentioning coal, it should be pointed out that recent advances in directional drilling and hydrofracturing of shale gas reserves has caused natural gas prices in the U.S. to plummet and that for the first time recently US electricity production from natural gas exceeded that from coal. This is a dramatic shift with significant carbon emissions consequences.	Taken into account. Sorry. But we can not discuss the situation for each country in detail in this section. At fig. 7.1 it is visible that in North America the coal use comes down with some compensation from natural gas. When data will be updated this may become more visible.
9639	7	18	6	18	7	On what basis is coal's share in the energy mix expected to decline after 2010-2011? Reference? Evidence?	The references to the future were eliminated
13461	7	18	1	18	11	Text: "The slow trend to diversification of energy sources away [from] fossil fuels was blocked in last decade (BP, 2011a; IEA, 2011a; US DOE, 2011a). Oil continues to suffer a long run decline in global energy market share. Nonetheless, despite energy security and climate concerns, oil demand was growing by 1% annually driven mostly by non-OECD transport with OECD demand likely peaked in 2005 and expected to decline (BP, 2011a; IEA, 2011a). Coal demand was growing by over 4% per annum and accounted for nearly half of the increase in global energy use in 2001-2010. The share of coal in the global energy mix after peaking around 28-30% in 2010-2011 is expected to decline. About all coal demand growth originated from non-OECD countries (Figure 7.1) with China pivotal in determining the future of global coal market (IEA, 2012a). With 2.7% per year consumption growth natural gas lost the status of the fastest growing fossil fuel to coal in the last decade. It is expected that its share will be back to the increase trajectory after flattening (IEA, 2012a)." Although BP analysts and others have suggested that there will be "peak oil demand", this is not conclusive. Most of the drop in oil demand over the period 2006 to 2010 could be viewed as a direct result of economic stress, and the downturn in oil consumption was reversed as soon as there were signs of economic recovery. If the economic flows are disrupted again, and if the global economy contracts permanently, this still may not signal "peak oil demand", as even in the contracted economy, there could still be strong demand for oil.	Taken into account - comment is obsolete. Underlying text has been deleted.
13462	7	18	17	18	18	Text: "The rate at which modern renewables penetrate the global energy market is similar to the emergence of nuclear power in the 1970's and 1980's (BP, 2011a)." It is interesting to note this, and it is also interesting to note that the underlying financial support for this is of a very different form. Nuclear power required intensive centralised state financial and framework support, but renewable energy technologies are more quickly profitable so do not require more than an initial "hand hold", such as widely used feed-in tariffs.	Taken into account - comment is obsolete. Underlying text has been deleted.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13463	7	18	19	18	30	Text: "7.3.1.2 Evolution of global energy-related GHG emissions : According to the EDGAR 4.2 FT 2008 dataset, global total greenhouse-gas emissions increased by 27% during the 1990-2008 with CO2 emissions from fuel combustion (+40%) drove much of this increase accompanied by CH4 emissions from fossil fuel production (+43%) (EIA, 2011). CO2 emissions trajectory partly mirrors the story of the global economic cycle and after decline in 2009 by about 2% regain over 5% in 2010 and by another 3% in 2011 reaching historical maximum of 31.4-33.2 Gt CO2- eq. (BP, 2011a; Enerdata, 2012; IEA, 2012a). In addition to the strong TPES growth, the last decade (2001-2010) was marked by the failure to decarbonize global fuel mix (Figure 7.5). The decade with the strongest ever carbon emission mitigation policies will be remembered as the one with the highest in last 40 years emission growth (2.6% per annum) driven mostly by additional coal use (by two thirds) and by growing power and heat generation (Figure 7.5)." The failure of global carbon policy, up until now, to start significant decarbonisation, suggests that it is unviable. Renewable energy capacity is being added, but this does not displace carbon energy in many cases. The efforts to make high carbon energy relatively more expensive than low carbon energy are not effective because the policies are based on microeconomic behaviour models - it does not trigger low carbon energy investment - whereas significant targeted capital is required to leap this hurdle and create an energy market with deep renewable energy penetration.	This is just comment without clear suggestion. Does reviewer want we add the proposed text? There are some discussion along those lines in section 7.3.3 and later in the chapter.
7121	7	18	19	18	33	This section should be merged with section 7.3.1.2 as they have a common theme	The table of content for the chapter is fixed. So those two subjects are related but different.
18643	7	19				Page 19: Studies do not support the leapfrogging hypothesis that developing countries would shift towards isgnificantly less carbon-intensive energy use patterns while bridging income gaps with developed ones. If so, what is the conclusion?	At this section historical emission is described. Conclusions and long -term options are covered in section 7.12.
6422	7	19	19	19	20	"Global picture masks significant regional disparities." is an awkward (incomplete?) sentence.	The following sentence clarifies it.
2826	7	19	19			At some points, as in this sentence, a little more precision would be helpful. Income is probably the main determinant of demand for energy services but demand for energy is also a function of the equipment in use, and there is at least some evidence of an S-curve leading to a levelling off of energy demand at higher income levels.	The detailed description of drivers is the subject for chapter 5 which comes before chapter 7. They discuss this issue there.
18046	7	19	24	19	24	New formulation needed.	From the comment, it is not clear what needs clarification.
16794	7	19	25		26	What drove this -- why were they different? Unclear.	More explanation of this is presented in chapter 5.
12031	7	19	25	19	26	Isn't this the reflection of poor energy efficiency at the beginning?	At the beginning of what? It is a reflection of very good structural reforms, which made such deep reductions possible (see fig. 7.6). Those countries had high energy intensities for decades, but under command economy failed to reduce them. So the issue is not the starting point. Today the US and Canada have much higher energy intensity comparing with Japan.
18047	7	19	27	19	29	Unclear formulation	From the comment, it is not clear what needs clarification.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16795	7	19	27		35	List of percentages is not that helpful. For the paragraph, hard to readily see meaning -- what is the significance of this? Could a graph with quick explanation be better?	It reflects dynamics. More on this issue is presented in chapter 5.
16793	7	19	3		8	Was this hypothesis based on the "no policy" scenario, or on scenario with a global CO2 price? The development of the energy sector will be very different with a long term, robust and durable CO2 price on emissions.	All this page is on historical evolutions, not on scenarios.
12032	7	19	36	19	41	The change of carbon intensity very much depends on the period you choose. If you choose 1980, OECD Europe is not the fastest area. Comparison of absolute intensity should be discussed together.	This is not true. In 1981-1990 the OECD still was doing much better than the rest of the world
17218	7	19	41			the authors are requested to check the reference. To my knowledge this reference is not dealing with the development of carbon intensity, but with energy potentials and endowments.	We did double check, but this statement is referred appropriately.
4431	7	19	5	19	8	What explanations are offered for developing countries not leapfrogging?	Here this is only presented as a fact. The explanation should be available from chapter on sustainable development
2583	7	19	5	19	8	Other studies (mainly made by Dan Kammen) scientifically proofed that Renewable energy creates more jobs than conventional energy (between 3.5 and 5 times). So, It would be an opportunity, beyond the finding, for the developing countries, specially those lacking fossil energy resources, to invest in renewable energy	Chapter 7 has special section on it (see section 7.10.4)
11921	7	19	5			Think you mean "data do not support" rather than "studies ...."	The wording is "Studies do not support" not data
6229	7	19	6	19	30	The lines 6-8 and 27-29 are contradictory	They are not. GDP energy intensities in developing nations are moving down faster than in OECD countries thus converging in the long-term but mostly along the same trajectory. We added "in the long-term".
5951	7	19	9	18		Should energy efficiency improvement not also be considered as a driver of energy demand in addition to population and economic growth. This also contributed to the stable demand in OECD Europe	It is considered and plotted at fig. 7.2
9640	7	19				Why is data to 2009 and not 2010/2011? Surely there is more recent data available?	As more recent data appear they will be used.
13465	7	19	14	19	15	Text: "Population and income growth are the two most powerful (but not the only) driving forces behind the demand for energy and energy related CO2 emissions." A significant driving force that should be mentioned is "state direction" - in other words, the intentions of governments, who are the leaders in plans for the built environment, transport and industry.	The intention of the section was not to list all drivers. This is a subject for chapter 5. Here only Kaya like identity factors are reflected to see how slow we move and to set a stage for following sections.
6547	7	19	15		18	Explain more in detail or give a reference paper, as the description here is not clear enough partly because of the indicators not found on Figure 7.6.	Taken into account. Cannot do this within page limits. See chapter 5 for more details. Reference to chapter 5 is made.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13466	7	19	19	19	20	Text: "Income evolution is the most influential determinant on the overall demand for energy. Global picture masks significant regional disparities." Income is not directly causally related to demand for energy. Changing lifestyle aspirations for consumption are constructed by corporate marketing mechanisms, and state leadership or urban development and manufacturing creates an energy-hungry environment.	More discussion of driving forces interplay are reflected in chapter 5. Here only Kaya like identity factors are used. Income make possible acquiring decisions and relationship between income and energy use is discussed in chapter 5
10045	7	19	2	19	41	The regional data for the demand trends should include graphs for a better overview - especially the TPES trends and the energy intensity trends by region	Those are to be provided by chapter 5
13467	7	19	25	19	26	Text: "This region was the only one that managed to decouple economic growth with energy use: its GDP in 2009 being 6% above the 1990 level while TPES declined by 32% over the same period." The reasons why total primary energy supply (consumption) dipped in the Non-OECD Europe and Eurasia region are not necessarily to do with improved energy efficiency of productivity or a greater use of low carbon energy - the collapse of the former Soviet Union saw Russia and its former satellite states experience considerable economic hardship. Thus it may not be reasonable to claim that economic growth was decoupled from energy use.	That opinion reflect shortage of literature on this subject. The facts are: many of those countries rebuild there 1990 GDP in 2000-2008 using 30-50 energy less and emitting 30-40% less. This is EE contribution. See fig. 7.6 and compare 1991-2000 and 2001-2009
13468	7	19	33	19	41	Text: "Besides technical improvements, falling energy intensities reveals structural changes away from industry toward less energy intensive activities – first in rich and then in newly industrialized economies...most developing countries show little or no de-carbonization. Historical trends reveal that rising carbon intensity is a common feature of many developing nations in early industrialization stage in which heavy use of fossil fuels for power production plays a key role (Rogner et al., 2011)." Falling energy intensities as countries move their economies away from industry towards a service/knowledge/finance economy indicates that carbon dioxide emissions from energy use have been outsourced to other countries through the process of the globalisation of industry. There is a natural stop point to this process - those developing countries that have taken on the manufacturing burden will not be able to outsource their energy use commitment to completely undeveloped countries - who simply do not have the infrastructure to do this. A counterpoint to this argument that falling energy intensities resulting from high levels of development (known in some circles as the "Kuznets Curve"), is that countries like the United States of America are considering re-starting some of their manufacturing at home - to create jobs. It is to be expected therefore, that the USA, and other countries who re-home their manufacturing, will see rising energy intensities.	Just to make this point clear. Structural change contribution in Chinese economy was responsible for about 50% of energy intensity reduction, while in many EU economies only for 20-30%. The faster economy develops the larger is the contribution of structural factors. In last two decades energy intensity was declining faster in developing nations mostly due to higher contribution of the structural factor. The exception is when economic growth becomes over 10% per year. At that point structural changes are providing no or negative contribution due to the fact that such growth and corresponding accumulation rate require structural shifts in favour of very energy intensive industries.
13464	7	19	5	19	8	Text: "Studies do not support the leapfrogging hypothesis that developing countries would shift towards significantly less carbon-intensive energy use patterns while bridging income gaps with developed ones (Jakob et al., 2012)." Carbon-intensive energy vendors, and those selling high carbon energy power plant and high carbon fuels, may be doing less business in developed countries, and so have turned their attention to markets elsewhere. A parallel can be found in the health policy to reduce smoking - more cigarettes end up getting sold in China for example. This suggests there should be obligations on energy companies to diversify their portfolios.	So, what is the comment? Does reviewer agree or disagree with the statement?

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6237	7	2	10			Long-term price trends are missing	Rejected - comment seems to be misplaced. Long-term price trends based on projections are quite arbitrary.
6238	7	2	13			integrated coal and still integrating global gas market should be dealt with in more depth since a sustainable global price trend supports climate change mitigation.	Rejected - comment seems to be misplaced. It is not clear what the reviewer means. Please clarify.
13024	7	2	11	2	11	[...but also because we measure now emissions more accurately, and are focusing all our attention on these processes.]	Wrong page references. It is page 5. If more accurate data appears the emission for previous years is adjusted. So, the accuracy of emission evaluation does not play serious role.
13025	7	2	21	2	21	Therefore, constraints	Taken into account - comment is obsolete. Statement has been deleted.
13026	7	2	22	2	22	limit global GHG concentrations to the agreed levels	Taken into account - comment is obsolete. Statement has been deleted.
13027	7	2	30	2	30	energy supply sector is high, despite their limited widespread deployment.	Taken into account - comment is obsolete. Statement has been deleted.
13028	7	2	42	2	42	efforts to overcome most of	Taken into account. Overcome does not fit the following text.
13029	7	2	43	2	43	proliferation risks.	Accepted - text revised
13030	7	2	44	2	45	reactor technologies and the management of the fusion reaction, trying to reduce the unsolved problems of nuclear energy use.	Taken into account. There is no much on fusion in the chapter to put it in the ES
13031	7	2	45	2	45	It is argued that the capture and storage	Chapter provides practical examples for CCS implementation, which confirm this statement.
13023	7	2	9	2	9	rationalize the energy sector [Failure to rationalize the energy sector, i.e., to implement a better fuel use in transport, industry, etc.; driving a progressive rational and efficient use of energy, diversification of energy sources, technologies and system configurations (including ICT, DG, smart grids, etc.). In this framework, decarbonization is at best a piece of the whole picture of energy and development.]	Noted
10510	7	20				Once again does "energy-related" include transport?	No. It is only energy supply sector emissions in SOD.
3156	7	20	1			I would keep figures 7.5 and 7.6 and pare back the rest	All figures were modified in SOD.
9641	7	20	14	20	20	This paragraph would be better shown in a chart	Such chart is included in the SOD.
4432	7	20	17	20	19	Repetition of sentences from p xx, line xx illustrating how China has become the world's largest emitter of CO2.	Taken into account - comment is obsolete. Underlying text has been deleted.
16035	7	20	5			unclear: de-carbonization progress from -0,3% per annum is a rise of carbon???	This comment is not clear.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16796	7	20	7			Suggest insert after "... below the 2000 level." the following sentence: "This is consistent with analysis that suggest that end use energy efficiency improvements are likely to occur before large changes in energy supply technologies." This helps the reader understand a plausible sequence of deployment in a transition to a low emitting future.	Here we just are dealing with historical data. So we may say that it happened leaving for section 7.11 to say what is likely for the future.
6182	7	20				Consider taking the two main points of this section – that despite some countries' progress towards decreased carbon intensity of energy, the massive growth of China and India more than make up for this and that the US has been eclipsed as the biggest emitter – and weaving them in to the previous section.	Taken into account -text revised.
13471	7	20	22	20	26	Text: "The relatively few studies that undertook ex post verification of energy model baselines (e.g., Pilavachi et al., 2008; Strachan, 2011), or the US DOE's review of its energy forecasts (US DOE, 2011b), showed the evolution and inclusion of current policies was a key determinant of projected energy supply, demand, and prices." This re-emphasises the point that energy consumption management needs to be subject to organisational administration - countries and regions need strong leadership, regulatory mandates and verification processes.	Wrong page reference. Within the new sectoral policy subsections, regulation, verification, and organisation administration are now covered in 7.11.3
7122	7	20	4	21	5	See comment number 5	Should be already dealt with
13469	7	20	5	20	6	Text: "Energy de-carbonization progress in OECD countries (-0.3% per annum) was smaller than in three previous decades" This low figure indicates that current decarbonisation policies are not producing a sustainable gradient of change in the general economic context. It also suggests a lack of organisation of energy use. Whilst is becoming evident that companies and corporations are beginning to consider their Energy Management, by contrast public sector administration and household consumption are not being subjected to the same kind of targetting. Whilst it is perfectly possible to implement strong energy conservation measures on homes, offices and public buildings, and transport systems, there needs to be political and social organisational will to make it happen. Without new energy saving management services, the GDP/GNP cannot become more decarbonised.	We agree with this statement. Much of these issues are to be discussed in chapters 8-10.
7120	7	20	5	21	5	Comparison of energy related emissions between OECD and non-OECD countries does not give a better picture. It is being proposed that comparison of energy related GHG emissions be based on International Comparison Program (ICP) Regions Groups developed by world bank. Information on this aspect could be found on the website; <a href="http://siteresources.worldbank.org/ICPEXT/Resources/ICP_2011.html">http://siteresources.worldbank.org/ICPEXT/Resources/ICP_2011.html</a>	Rejected - space constraints do not allow to go into the details here.
13470	7	20	7	20	10	Text: "In non-OECD countries, average annual increase of energy-related CO2 emissions exploded from 1.1% in 1990-2000 to 4.7% in 2001-2010 due to the expansion of TPES accompanied by growing carbon intensity of energy of 0.6% per annum, driven to a large degree by coal demand in China and India (IEA, 2011a)." From the point of view of economic and social development, an increase in the use of energy in a country is a positive signal. Energy enables capacity.	We do not share this opinion. Recent experience shows that energy services rather than energy resources do promote growth, but they can be produced using much less energy (see discussions on E potential in chapter 8-10).
9642	7	21	1	21	5	This paragraph would be better shown in a chart	With given page limit is it not possible
18048	7	21	1	21	2	Add the figure for OECD Europe	Figures for SOD were modified.
10511	7	21	10			Need references, not just database names	Taken into account - comment obsolete. Underlying text has been deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16798	7	21	11			Suggest add at end of paragraph: "Many consist of technology standards, subsidies for preferred technologies and simple admonitions to "be green." Some regions have used CO2 pricing mechanisms."	Taken into account - This section has been merged with 7.12, with pricing technology and enabling policies explicitly addressed in these 3 subsections, and the fullest policy discussion in chapter 15
18051	7	21	15	21	15	Add "and nuclear energy" after "fossil fuel"	Taken into account - the point here is that fossil fuel subsidies removal benefits all low carbon technologies. A discussion of nuclear (and indeed wind) support measure should be in section 7.12)
7727	7	21	16	21	18	First of all, there is just on Copenhagen Accord, therefore the plural in meaningless. Secondly, The Copenhagen Accord is not even listed in the UNFCCC main website as a significant milestone in multilateral Climate Change negotiations. Please, refer to the Kyoto Protocol as the main accomplishment and whose GHG emission targets should be met.	Taken into account - Refer to Cancun Agreement / Copenhagen Accord as per Co-Chair's recent guidance letter
16799	7	21	19		29	Not apparent how this is useful for discussion -- suggest delete.	Taken into account - comment obsolete. Underlying text has been deleted.
3779	7	21	26	21	26	Spell RCP in full the first time it appears.	Taken into account - comment obsolete. Underlying text has been deleted.
7728	7	21	30	21	31	Emission reduction pledges have no importance in the UNFCCC negotiations. Countries are not obliged to go by the and they will not be charged for it. Kyoto Protocol emissions reductions pledges are the ones that should be mentioned in the text. I fail to understand why the main agreement on multilateral climate change negotiations has been left out of the text.	Taken into account - Refer to Cancun Agreement / Copenhagen Accord as per Co-Chair's recent guidance letter
16800	7	21	30		40	This is very important point and should not be significantly changed.	Taken into account - comment obsolete. Underlying text has been deleted. The important part was moved to the intro of section 7.12.
10512	7	21	30	21	40	Most of this covered in Chapter 1. Suggest check first - then delete	Taken into account - comment obsolete. Underlying text has been deleted. The important part was moved to the intro of section 7.12.
18049	7	21	5	21	5	France is not an appropriate reference, since its power sector is close to carbon free (nuclear and renewables)	Taken into account - comment is obsolete. Underlying text has been deleted.
16797	7	21	5			Suggest add at end of paragraph: "this reflects the stronger linkage of emissions per unit of economic activity rather than emissions per capita. As discussed in chapter 6, changes in energy technology choices can change this linkage."	Taken into account - comment obsolete. Underlying text has been deleted.
4642	7	21	6	21	6	Current policies and GHG reduction. As pointed out above, the use of more biomass seems an obvious goal.	Taken into account - this section does not discuss specific mitigation option but the role of biomass is discussed in detail in chapter 11, and here in Chapter 7 in sections 7.4.3, 7.5.4, and 7.12

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18050	7	21	7	21	7	It seems odd to refer to the EU in a sentence that describes climate policies as poorly coordinated across national boundaries. 27 nations agreed on the climate and energy policies unanimously.	Taken into account - in new section 7.12.3 word editing makes clear EU policies are not as well coordinated with non-EU countries
6183	7	21				The points made in this section are strong and should be continually emphasized throughout this document. The notion that despite our inability to stop trying to "talk the talk," we've really been unable to apply policy tools to reduce GHG emissions in a meaningful way.	Noted
18506	7	21				As the chapter is so far over its allocated pages, this section could be merged with the policy and scenario discussions in 7.11 and 7.12. This additional text is unnecessary.	Taken into Account - this section has been merged with 7.12, with pricing, technology and enabling policies explicitly addressed in these 3 subsections.
6787	7	21	6	22	7	It may be helpful to move and merge contents under section 7.3.3 to section 7.10. Policy may be discussed as a topic under "Barriers and Opportunities" and retain the flow	Taken into account - Co-chairs recommendation and chapter decision was to merge 7.3.3 with the sectoral policies chapter (7.12)
11922	7	21	6			Why is this section not in Ch 15?	Taken into account - comment obsolete. Underlying text has been deleted.
10046	7	21	6	22	7	This section should include the results of the scenario analysis of the SRREN report. The entire section is almost exclusively based on IEA projections.	Rejected - for reasons of space the IEA scenarios were used as an exemplar here. A full discussion of the SSREN listed scenarios will be elsewhere in AR5 (chapters 5, 6, 7.12)
16801	7	21				Why lead with what seems to be tacit agreement with peak oil theory and then explain it away after the 1st paragraph? Please state at the beginning that peak oil theory fails to account for what you very well describe later in the section. The reader who is pressed for time will stop after the 1st paragraph and leave with incorrect views.	Taken into account - comment obsolete. Underlying text has been deleted.
12324	7	21	6			Please consider to use a different title for the section. An example is "GHG emission projections", as it might better reflect the text.	Taken into account - comment obsolete. Underlying text has been deleted. The important part was moved to the intro of section 7.12.
2970	7	22	1			Starting the y-Axis at 20 Gt is misleading since reader on a first glance think that emissions have to be reduced nearly to zero already by 2040 to reach the 450 ppm scenario. Better show full y-Axis but extend projection to 2050 or beyond.	Taken into account - Figure has been deleted; comment is obsolete.
7729	7	22	10	22	12	This is not completely true. It is hard to tell how "rapidly" demand will lead to exhaustion of remaining supplies, since technologies advance, making supplies that could not be extracted at present available in the future. This could expand supply, postponing a possible exhaustion.	Taken into account - combined with other comment: See response to comment 3389. Text deleted
6184	7	22	10	22	12	"Oil, natural gas and coal are finite resources that cannot be reproduced in human time frames. Any extraction depletes the stock, and demand growth will rapidly lead to the exhaustion of remaining supplies." This theory of depletion vastly oversimplifies economic reality and history. As stated in line 21 on p. page 22, "Resources, therefore, are not fixed things." Conclusions of exhaustion, scarcity, and depletion cannot be justified from the information presented.	Taken into account - simplification a necessity given space allocation. Text deleted.
5346	7	22	11	22	11	Exhaustion will not necessarily be "rapid" - depends on the stock and rate of demand growth	Accepted. Text deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2993	7	22	11			Please, withdraw rapidly from the text. The rhythm of the depletion cannot be defined in a such simplistic manner.	Accepted - text revised: Simplification a necessity given space allocation. Text deleted.
6185	7	22	15	23	24	While this section makes some great points, it seems as though it could be condensed. The main point – that our use of fossil resources has varied historically depending on market forces, technology changes, and social factors – should remain, but its current length could be decreased.	Accepted - text revised.
10513	7	22	15	22	20	Better shown as bullets and remove "first" "second" etc.	Text shortened. First, second etc. no longer exist.
7730	7	22	18	22	19	Not to consider technological progress is a strong hypothesis and not very realistic.	Taken into account - Technology change is considered
6423	7	22	21	23	9	I believe that there is significant agreement on the definitions of resources and reserves. This text articulates the distinction on page 23, beginning in line 3. The description of the changing "stocks" of resources is actually about reserves. I like the articulation, but the "resource" and "reserve" description seems to need tightening, which comes at the top of page 23. I suggest that the definitions be stated upfront and then have the articulation of the changing stocks (from prices, technology, demand, etc.)	Accepted - text revised.
18202	7	22	21		29	Add to paragraph: Resources, therefore, are not fixed things. What matters is the timely availability of a resource in the market place at competitive costs. Changing market prices for a mineral may expand or contract the economically recoverable quantities. If a resource becomes too expensive the market responds in two ways: consumers tend to shift to alternative resources (demand reduction); and producers seek additional supplies through enhanced exploration activities and innovative production methods, thus enabling production from previously inaccessible deposits. Moreover, technology change and improvements in knowledge push the frontier of exploitable resources towards deeper, more remote or lower concentration occurrences, making resources a dynamically evolving rather than a 'fixed' quantity. Nevertheless, this "dynamics" is not an endless process; it depends also from other changing variables.	Rejected: There is insufficient space for these observations.
18203	7	22	21		29	Alternative paragraph: Resources, therefore, are not fixed things. What matters is the timely availability of a resource in the market place at competitive costs. Changing market prices for a mineral may expand or contract the economically recoverable quantities. If a resource becomes too expensive the market responds in two ways: consumers tend to shift to alternative resources (demand reduction); and producers seek additional supplies through enhanced exploration activities and innovative production methods, thus enabling production from previously inaccessible deposits. Moreover, technology change and improvements in knowledge push the frontier of exploitable resources towards deeper, more remote or lower concentration occurrences, making resources a dynamically evolving rather than a 'fixed' quantity. Nevertheless, this "dynamics" is not an endless process; it depends also from other changing variables.	Rejected - text needed shortening. Suggested alternative text still too long.
10514	7	22	21			Suggest "Resource availability therefore is not fixed." Change "of a resource" to "of an energy resource"	Accepted - text revised: Text no longer exists.
2994	7	22	21			The meaning of resource is not correct. Resource does not change with costs, but reserves do.	Rejected. The reviewer is wrong. Occurrences do not change with costs resources do (see shale oil and gas in the US which previously were considered "unconventional resources."

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2995	7	22	28			Again, the meaning of resource is not correct. What evolve with costs are reserves and not resources. This is a big error in the manuscript. Please fix it.	Rejected. See previous comment 2994 ("Rejected. The reviewer is wrong. Occurrences do not change with costs resources do (see shale oil and gas in the US which previously were considered "unconventional resources.").
3389	7	22	8	28	15	This is an example of a very poor section. Full of rethoric paragraphs with little and disperse interesting information. Author prejudices about the debate on peak production are obvious in the first paragraph: "...rapidly lead to the exhaustion of remaining supplies" ..."inevitable decline"...followed by a superficial second and third paragraphs (should be deleted? between page 22 lines 15-20). Unfortunately for the climate system of this planet, reserves scarcity is not really a problem...Very long introduction of simple concepts in page 23 between lines 12 and 37 (delete?). This is a missed opportunity to present in a consistent manner the problem of the huge reserves of fossil carbon: the important numbers on carbon reserves in page 23 line 36-37 and 38-39 do not get a single reference j j (while this chapter used 38 pages for references j j j). Figure 7.8 also contains very important numbers (that are indeed very, very large and relevant in a report about energy and climate change): therefore this figure cannot be supported by a grey looking reference like Farrel (2008) when there are major databases (IEA?, BP?) reporting these type of numbers. The same applies to line 25-26 in page 24. Delete rethoric paragraph in page 25 lines 6-13. Page 25, Table 7.2 on fossil reserves (missing) may be very important and should be based in major international organization reports. The emerging concept of "carbon bubble" (associated to the huge market value of carbon reserves and the financial bubble that would burst if these reserves are not exploited), should be discussed somewhere in this section or elsewhere in this chapter.	Taken in to account- text revised. Reviewer seems to be unaware that the GEA reference is based on BP, USGS, BGR, WEC and other databases. "grey looking" reference to Farrel is preposterous - the data are GEA but the concept of presentation was 'borrowed' from Farrel. Carbon contents calculated from GEA energy resource data using IPCC intensities. Finally text changed and the "peakist" touch detected (wrongly so) by the reviewer deleted.
4808	7	22	9	26	26	This section can be shorter	Accepted - text revised. Text made shorter.
13472	7	22	5	22	7	Text: "This need for a radical break in current trends and the challenges of GHG reduction policy implementation illustrates the absolute scale of the GHG mitigation challenge." Since most things in economies seem to happen as a result of monetary reward, it would be tempting to suggest that policy could better be implemented by offering financial incentives. However, the changing climate and energy insecurity may prove quite sufficient in creating incentives for change - based on the financial implications of actuated risk.	Taken into Account - This section has been merged with 7.11, with pricing technology and enabling policies explicitly addressed in these 3 subsections.
10047	7	22				This graph does not reflect the text above. Other than only IEA scenario projections should be included (see SRREN, Chapter 10)	Taken into account - comment obsolete. Underlying text has been deleted.
15484	7	22		28		(part of the text is not visible in the Excel block) - Resources and resource availability - Very well presented. Suggestion to introduce somewhere a paragraph (introduction words) on "available" resources and "climate change patterns". In another word, resources already well identified and other potential ones are already enough to go much over than a 450 ppm trend - see IPPC SRREN, IEA or others.	Accepted - text revised. Emphasis on climate implications added.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13474	7	22	23	22	24	Text : "If a resource becomes too expensive the market responds in 24 two ways: consumers tend to shift to alternative resources (demand reduction)..." This is not necessarily so. It is a tenet of microeconomics that this is so, but much energy use is inelastic, regardless of the price, and without deliberate regulation, policy, targeted investment focus and stimulus, alternative energy resources will continue to play a minor part in energy markets. Because we are so dependent on energy, energy price rises will only serve to create inflation, which will be followed by re-equilibration of the economy, having zero net effect. Energy price rises will not necessarily precipitate energy conservation or energy efficiency, in fact, it may make it more difficult for people to choose to do energy conservation and energy efficiency. Most energy efficiency of production is likely to be driven by regulation and policy, rather than the cost of energy. Most end-use consumer energy conservation is likely to be driven by subsidies, grants, loans and other monetary assistance. Most energy vendors will wish to increase energy sales, regardless of obligations to sell energy services such as conservation.	Noted. We talk here long-term. In the short-run demand is relatively in elastic - but not necessarily over a period of 20-30 years. Text deleted due to space limitations
13475	7	22	24	22	29	Text : "...producers seek additional supplies through enhanced exploration activities and innovative production methods, thus enabling production from previously inaccessible deposits. Moreover, technology change and improvements in knowledge push the frontier of exploitable resources towards deeper, more remote or lower concentration occurrences, making resources a dynamically evolving rather than a 'fixed' quantity..." This is also not necessarily so. It may not be possible to generate a healthy return on investment by going after harder-to-reach fossil fuel deposits - in which case, despite good new technology, innovation would fail.	Rejected - harder to reach deposits precisely means different technology - hence innovation
6788	7	22	8	28	14	It may be helpful to shorten, move and merge contents under section 7.4 to section 7.2. This move may be helpful to reduce the number of pages and yet retain the flow. Section 7.2 may be further renamed to appropriately reflect the revised contents.	Rejected: text revised and shortened and 7.2 emphasis and topic is separate to this section.
3157	7	22	8			Section 7.4 is way too long. Is anything needed here but one figure and a brief discussion focusing just on what's new since AR4? For most folks, it will be striking to have as much discussion of liquid and fissile reserves and relatively less on gas.	Accepted - section shortened
7123	7	22	10	23	14	These paragraphs may be deleted as they do not add much value to the section	Taken into account - text revised: Text shortened, but definitions have to be retained.
9226	7	22	8	22	8	Change title by "Reserves, resources and occurrences"	Rejected - section titles cannot be altered.
13211	7	22	9			This part could be shortened and the main conclusion relevant to mitigation contained in the last sentence (page 25, line 17/18 ° should be emphasized "Fossil reserves alone contain two to four times that amount of carbon a daunting outlook for climate stability."	Accepted- text revised: We talk here long-term. In the short-run demand is relatively inelastic - but not necessarily over a period of 20-30 years. Text deleted due to space limitations
12325	7	22	9			This section seems a somewhat unbalanced. Fossil fuels are getting a lot more attention and details than renewable resources. We recommend shortening chapter 7.4.1 significantly and emphasizing the point being made on page 25 line 14-18.	Accepted - fossil resource section reduced. Emphasis added.
4433	7	23		25		These pages contain background reading of a related topic. They should be omitted to maintain the focus of the chapter and reduce its length	Accepted - text revised: Text shortened.
10515	7	23	1			As above	Rejected - essentially applies to all materials

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2996	7	23	1			There is a consensus about the meaning of reserves and resources. Hence, I disagree with the text. Please see SPE, BP, and IEA, only to cite few references. SPE in the 1990s established the probability ranges related to all kind of reserves (P, 2P, 3P). Indeed, the fact that the meaning of reserves and resources is well established does not imply in a precise application of it. This is another question, which involves the bias when stating petroleum reserves.	Rejected - reviewer is wrong. There may be some consensus within various resource sectors, e.g. oil - but not universally (Russia has a different definition, etc.) There is certainly NO consensus between coal, oil/gas and uranium. BP, IEA O&G etc. use the same info source for conventional oil and gas reserves (no resources in BP) - no consensus there really. See Reference: Nick A. Owen, Oliver R. Inderwildi, David A. King, "The status of conventional world oil reserves—Hype or cause for concern?" Energy Policy 38 (2010) 4743–4749. And with regard to unconventional oil/gas there no such thing.
4105	7	23	10	23	14	The political nature of 'proved reserves' data for conventional oil should be explained and the underlying facts set out. Saudi Arabia's ~ 260 billion barrels has scarcely changed over the past 20 years, nor has Kuwait's ~ 100 billion, nor UAE (Abu Dhabi's) ~ 98 billion since 1985. The late Matt Simmons and Hans Jud have taken an extreme position. Sadad Al-Husseini and Obaid Nawaf (both ex-ARAMCO senior geologists) quoted a figure of 140 billion barrels for Saudi Arabia over five years ago. The January 2007 issue of PIW Weekly reported its sight of a confidential report placing Kuwait's proved reserves at 48.5 billion barrels. The UAE has produced over 24 billion barrels of oil since 1985. Thus the current Saudi position is likely to be about 190 billion barrels; Kuwait 43 billion barrels; and UAE 74 billion barrels. In none of these countries have there been significant new finds in recent years.	Rejected. No space here for the politics of oil.
16802	7	23	14			before end of last sentence, perhaps add: ... "demonstrating that as current sources are depleted and price moves to higher levels, more costly sources are developed."	Rejected: Although the reviewer is correct, space limits prohibit a detailed discussion on these points.
10516	7	23	14			Add ... "estimated" oil reserves	Rejected: text deleted due to space limitations
9261	7	23	15	23	20	The concepts are changing too, in that shale gas is now becoming conventional/common. The techniques for shale gas are not new - horizontal wells and fracking - so they are extractable using techniques for conventional hydrocarbons, though you do qualify the statement with "generally".	Rejected: Although this true, the term generally still applies.
2827	7	23	18	23	20	The definition of "unconventional" is unclear and seems to mix together geological, economic and engineering considerations – how does EOR, for instance, fit in? It is not normally regarded as unconventional but appears to be covered by the definition here. (Admittedly, there is no standard international definition, but the text does not clarify anything).	Rejected. There is no universally accepted definition of unconventional - EOR is a borderline issue. Due to space limitation clarification cannot be accommodated.
10517	7	23	21	23	24	Could add an example of fracking here.	Accepted - but text changed due to space limitation

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16803	7	23	23			Suggest you add after the word "development" the following "and cost relative to prevailing market prices."	Accepted: Text revised.
9643	7	23	28	23	28	Additional quality criteria does not impact on the reserve statement - but means that the cost for environmental controls increases	Accepted. No change required.
9239	7	23	30	23	30	Rogner' instead of 'Wagner'? (check bibliography section also)	Accepted - text revised: Wagner is correct. Text deleted.
16101	7	23	35	23	37	On coal reserves a reference could be useful	Accepted. Reference of summary table applies.
11924	7	23	37			Need reference	Taken into account: Reference is same as Table 1
10518	7	23	38			Data don't match those in Table 7.2. need to be consistent. Also for line 41. ZJ not commonly used so define in a footnote	Rejected - reviewer confuses Gt of oil in the text with Gt C (carbon) in the table
6424	7	23	41	23	42	This statement about peak oil is speculative.	Rejected: Data ranges reflect the uncertainty found in the literature.
6186	7	23	41	23	42	"When compared with cumulative past production of 162 Gt (6.8 ZJ), "peak oil" production is imminent or has already been passed." This is very misleading. The paragraph is referring to conventional oil production, but concludes that overall oil production is peaked. Peak oil for conventional reserves is misleading, much as a discussion of declining Nintendo sales -- without consideration of other systems and online gaming -- would suggest an overall declining in entertainment.	Rejected: As noted the text, without resource & unconventional, the peak is imminent - but with those resources this in not the case.
5347	7	23	41	23	42	Not clear you can infer peak oil (a peak and subsequent decline in annual production) is imminent based on ratio of past production to conventional reserves. The right economic conditions could deliver increasing annual production despite declining reserves. This paragraph really refers to "peak conventional oil", the economic significance of which is debatable given the size of the unconventional oil resource discussed in the next section. This section does not discuss the important implications of declining conventional resources and increased exploitation of unconventional resources (i.e. a persistently high oil price and higher lifecycle emissions of oil extraction).	Rejected: Peak is relative to currently known reserves only - and text is quite clear about the potential role of resources (in addition to reserves) and unconventional reserves and resources.
16804	7	23	42			Suggest you insert between "production" and "is" the following: "within current price ranges"	Rejected: peak as presented by the peakist school is independent of prices

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13476	7	23	12	23	14	Text: "For oil, the R/P ratio has fluctuated around 40 years for more than a century, while production has steadily increased. The quasi-constant R/P ratio could only be the result of an equivalent increase in oil reserves." This is also not necessarily so. It seems that the oil and gas companies have deliberately tried to keep their R/P at 10 or more years, in order to satisfy their shareholders. However, this does not mean that the level of reserves has increased overall. There appears to be a process of slowly adding already discovered and lower quality reserves to company or regional totals as needed to keep the R/P ratio at the desired level. For example, the enormous increase in proved reserves of South American (Venezuelan) oil reported in June 2011 by BP compared to June 2010 ( <a href="http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/2010_downloads/statistical_review_of_world_energy_full_report_2010.pdf">http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/2010_downloads/statistical_review_of_world_energy_full_report_2010.pdf</a> ), ( <a href="http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2011.pdf">http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2011.pdf</a> ) "Reserves growth" may be the explanation given for this phenomenon, but it may not represent a true expansion of a reserve.	Accepted - text revised: Text deleted.
13477	7	23	21	23	24	Text: "Unconventional resources require different logistics and cost profiles, and pose different environmental challenges. Their future accessibility is, therefore, a question of technology development, i.e. the rate at which unconventional resources can be converted into marketable fuels at competitive costs." I would suggest that although engineering technology can show and has shown strong development in the ability of energy production companies to exploit unconventional fossil fuel resources, that this has not improved the net energy return on exploiting hard-to-reach and complex resources, nor has engineering prowess been accompanied by an equivalent improvement in environmental protection owing to the more complex nature of those resources. I would therefore wish to see some statement about the possibility that much unconventional fossil fuels will remain "uneconomic".	Rejected. Statement was in the ZOD text, but was unfortunately deleted due to space limitations.
13478	7	23	25	23	28	Text: "Assessments and comparisons of global coal reserves and resources are subject to uncertainty and ambiguity, especially when reported in physical unit (tonnes) and without a clear distinction of their specific energy contents, which can vary between 5 GJ/t and 30 GJ/t." I would suggest that all reports of coal reserves, resources/occurrences should be treated to a matrix assessment, tabling their accessibility/cost profile, their likely energy content, and their co-factors such as sulphur compounds and associated gas. There are some coal seams that profit-making energy producers are simply not going to go after, but some of these may still be exploited if states develop national energy companies to do so. This means that the likely method of exploitation - either publicly or privately financed - is important in assessments of "economically recoverable" coal. I think an assessment of this should be included in this report.	Rejected: Although these are important points space limitations make this impossible.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13479	7	23	35	23	37	<p>Text: Coal occurrences are plentiful with reserves estimated at 13.3 to 21.0 ZJ (or 446 to 542 Gt C) and resources at 291 to 435 ZJ (or 7500 to 11,200 Gt C) globally." There is no reference here. I assume it is a reference to Rogner et al. 2011 (IIASA GEA Global Energy Assessment), summarised in Table 7.2. If so, there are two typographical errors, as the table shows reserves at 17.3 to 21.0 ZJ (not 13.3 to 21.0 ZJ as in the text) and resources as (7,510 - 11,230 GtC) not as (7,500 - 11,200 GtC) as in the text. As the Global Energy Assessment has only just been published (June 2012, launched at the Rio+20 Energy Day <a href="http://www.iiasa.ac.at/Admin/INF/PR/2012/2012-06-19.html">http://www.iiasa.ac.at/Admin/INF/PR/2012/2012-06-19.html</a>; published July 2012 <a href="http://www.iiasa.ac.at/Research/ENE/GEA/report.html">http://www.iiasa.ac.at/Research/ENE/GEA/report.html</a>), the chapters are not yet available on the IIASA website, so I cannot know if the work referenced researchers with different methodologies on coal reserves and resources, such as Professor David Rutledge of CalTech. He published in 2011, "Estimating long-term world coal production with logit and probit transforms", International Journal of Coal Geology, Volume 85, Issue 1, 1 January 2011, Pages 23–33, <a href="http://dx.doi.org/10.1016/j.coal.2010.10.012">http://dx.doi.org/10.1016/j.coal.2010.10.012</a>, <a href="http://www.its.caltech.edu/~rutledge/DavidRutledgeCoalGeology.pdf">http://www.its.caltech.edu/~rutledge/DavidRutledgeCoalGeology.pdf</a>. Rutledge's contribution is to calculate that the total of past and future coal production will amount to the order of 653 - 749 Gt, and that since 309 Gt has already been produced, that leaves 344 - 440 Gt left to produce. This amounts to the production of further reserves of = 9.98 - 12.76 ZJ (at 29 GJ/t), which is significantly lower than the reserves calculated by the IIASA GEA (GEA historical production is in terms of carbon emissions, and at 192 GtC gives an average of 62% carbon in the emissions from all the coal burned if Rutledge's historical production figure of 309 Gt is accurate. The energy value of the historical coal production is given in Table 7.2 is 7.426 ZJ, whereas at 29 GJ/t, Rutledge's historical production figure would be 8.961 ZJ). Others working on coal reserves and resources : "Validity of the fossil fuel production outlooks in the IPCC Emission Scenarios", Mikael Höök, Anders Sivertsson and Kjell Aleklett, in Natural Resources Research, Volume 19, Issue 2, June 2010, Pages 63-81, doi:10.1007/s11053-010-9113-1, (<a href="http://uu.diva-portal.org/smash/get/diva2:301406/FULLTEXT01">http://uu.diva-portal.org/smash/get/diva2:301406/FULLTEXT01</a>); Hook, M., Zittel, W., Schindler, J., and Aleklett, K., 2010. "Global coal production models based on a logistic model", Fuel 89, 3546–3558 (<a href="http://www.diva-portal.org/smash/get/diva2:329110/FULLTEXT01">http://www.diva-portal.org/smash/get/diva2:329110/FULLTEXT01</a>); Mohr, S.H., Evans, G.H., 2009. "Forecasting coal production until 2100", Fuel 88, 2059–2067 (<a href="http://dancass.com/static/files/assets/cced3021/GME__2009__J85.pdf">http://dancass.com/static/files/assets/cced3021/GME__2009__J85.pdf</a>) [702 Gt = 20.36 ZJ]; Patzek, T., Croft, G., 2010. "A global coal production forecast with multi-Hubbert cycle analysis", Energy 35, 3109–3122 (<a href="http://xa.yimg.com/kq/groups/20593576/885722944/name/Patzek+and+Croft+2010+-+Peak+Coal+2011.pdf">http://xa.yimg.com/kq/groups/20593576/885722944/name/Patzek+and+Croft+2010+-+Peak+Coal+2011.pdf</a>) [630 Gt = 18.27 ZJ]. All of this work points at lower recoverable reserves of coal than the World Energy Council 860 Gt coal at energy density of 29 = 24.94 ZJ (<a href="http://www.worldenergy.org/documents/ser_2010_report_1.pdf">http://www.worldenergy.org/documents/ser_2010_report_1.pdf</a>) and the BP 2012 report - 860938 Mt, which at 29 GJ/t = 24.97 ZJ (<a href="http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/coal_section_2012.pdf">http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/coal_section_2012.pdf</a>) The US Energy Information Administration (EIA) International Energy Outlook (IEO) gives total recoverable reserves of coal at 948 billion tons = 862.68 Gt (coal) at an average energy density of 29 = 25.01 ZJ (<a href="http://www.eia.gov/forecasts/ieo/pdf/0484(2011).pdf">http://www.eia.gov/forecasts/ieo/pdf/0484(2011).pdf</a>)</p>	Accepted - text revised: Coal reserves corrected. GTC data rounded.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13480	7	23	41	23	45	Text : "When compared with cumulative past production of 162 Gt (6.8 ZJ), "peak oil" production is imminent or has already been passed. Including resources extends oil availability considerably - essentially doubling reserves (Figure 7.8). Even the higher range of reserves and resources would only postpone the peak by about two decades (depending on demand) before global conventional oil production starts its inevitable decline." To call the current oil production situation "peak oil" is an important and potentially controversial statement. I would hope to see a development of this argument in order to shield it from attacks from the cornucopians who believe that the appliance of geopolitics can ramp up supply. I do not accept that unconventional oil resources will double reserves, for two reasons. First, the accessibility problems of large unconventional oil fields are to my mind an order of magnitude larger than conventional crude exploitation. Not only is access more complicated, and require special rigging and boring equipment, but the risk of interruptions in supply from problems such as well blowout, pipeline blockages, breakages and production spillages is so much greater. It will be found that some resources are not worth the attention. Secondly, I think that the rate of production from some unconventional resources is going to be so slow as to render them "uneconomic" by any value assessment. I think that the unconventional fossil fuel resources should be treated to an "exploitability assessment" rather than be grouped together in one number, which offers an unrealistic appraisal of availability. Figure 7.8 goes some way to addressing this demand, but the text does not offer a breakdown of what this figure implies. The point about extending the peak by about two decades is a very important point to stress. I would hope to see some modelling of this as demonstration of potential. Some people still believe that "putting off" or delaying peak oil is equivalent to maintaining current production for a very long time - this view needs to be addressed, in my opinion.	Taken into account-text revised: The reviewer makes some important points regarding the complex nature of non-conventional fuels, however space limits make it difficult to include these. The two decade time scale is made clear.
9644	7	23	36	24	8	The units used: Gt C for coal are different to oil which is just Gt - are these meant to be the same? For comparative purposes it would help if they were.	Taken into account: Gt C reflect carbon content - the C does not stand for coal.
9235	7	23	6	23	24	May be is possible send the definitions of Reserve, resources, conventional and un conventional to Annex I Glossary	Rejected - some basic knowledge is needed to provide the context here.
11923	7	23	9			need to add "believed to be present in the earth's crust based on current geological information". Also don't need fossil line 8, as this applied to any valuable material.	Accepted- text revised.
5133	7	24				the legend "tar sands" should be changed to 'oil sand'	Rejected: Both are used in the literature - however if the figure has to be redrawn this could be addressed.
16805	7	24				Excellent! Don't delete. Highlight if possible earlier in discussion to demonstrate how peak oil theory is not quite helpful.	Noted
6447	7	24				Spelling error: than (not 'chan')	Editorial
3780	7	24				Be clear regarding definition of production cost. Does it include exploration, exploitation costs? What about transportation cost up to refineries?	Taken into account- text revised: Production costs are all the costs getting the material to the surface - rest is not included. Text adjusted
18507	7	24				Please note the agreement in the AR5 to use 2010 as the base year for currency.	Taken into account - the currency will be changed for the FD.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10519	7	24				Hard to decipher this figure. A) Conventional oil and EOR labels relate to two bars - so add arrows to show that. B) Convert x-axis labels to ZJ as used in text OR, preferred, convert text to EJ as used elsewhere in chapter. C) Implies all oil produced to date was produced for \$4-10/bbl. Is this true? Not according to Fig 7.4 - though this is the oil price - not the cost I guess. Perhaps needs clarifying in caption. D) Suggest caption start "Liquid fuel reserve and resource supply potentials..." E). Only one reference for what is a contentious issue. Suggest an assessment of the literature be made and a new graph produced.	Rejected: The one reference is based on a comprehensive literature review including peak oil debate. These are production costs that cover 90% of production. Reviewer's reference to Fig 7.4 is not clear - no prices or costs there. Figure may be redrawn but not before SOD deadline
11925	7	24	10			WEC 2007 should be updated to WEC, 2010.	Accepted - Done
3781	7	24	25	24	26	What is the meaning of "Approximately 17% (135 million m3 or 5 EJ) is currently flared". It is easy to understand the 17% figure, but what is the meaning of 135 billion m3 as currently flared? Probably the last figure is obtained assuming the annual amount flared will remain stable in the future, until gas reserves already in exploration will be over. Please, confirm this interpretation.	Taken into account- text revised: text deleted due to space limitations
10521	7	24	25			5 EJ / yr I assume	Editorial, however text deleted
17363	7	24	33	24	34	Compare Chapter 1, page 9, 46: Conventional oil reserves will eventually peak, but it is uncertain exactly when and what will be the nature of the transition to alternative liquid fuels. Conventional natural gas reserves are large by scale, but less evenly distributed across regions.	Taken into account-text revised: Text no longer exist in Chapter 1 (and conventional nat gas are also more evenly distributed across regions) - text changed due to space limitations
10520	7	24	8			Have "oil sands" been omitted on purpose from the list? Either include or provide info separately	Accepted - done
13481	7	24	13	24	16	Text: "Oil prices in excess of \$80 per barrel are probably needed to stimulate investment in unconventional oil development." The possibility is that if oil prices remain as high as they have been, that the economies as a whole will suffer inflation, because of the high dependency on oil (inelastic demand). This will then make the relative cost of exploiting unconventional resources that much more expensive - and large sections of the unconventional resource will remain uneconomic to produce.	Taken in to account: Could well be - hence "in excess of 80\$ - e.g. see shale oil in the USA.

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13482	7	24	21	24	34	Text: "Conventional natural gas can be found as "associated gas" accumulated as a gas cap above an oil pool or with high reservoir pressures, dissolved in the oil or as non-associated gas. Recovery of associated gas is generally a by-product of oil production...Non-associated natural gas reservoirs are much more abundant than reservoirs with both oil and gas. When there are no significant liquid hydrocarbon components, a larger part of the in-place gas can be recovered by dropping reservoir pressures...Unlike oil, natural gas reserve additions have consistently outpaced production volumes and resource estimations have increased steadily since the 1970s [...]. The global natural gas resource base is vast and more widely dispersed geographically [t]han oil." I would suggest that it is important to explain a little about the change in the profile of hydrocarbon species the further down in the lithosphere fossil fuel drilling takes place. Deeper in the crust, the temperatures and pressures are higher, so there will be a tendency for fossil fuel fields to contain more gas (or more gas in solution). Natural Gas Liquids (NGL) could form a much higher proportion of some deepwater, subsea/submarine, deep pocket production than that from large oil fields nearer the Earth's surface. This higher overall availability of light hydrocarbon gases (and liquids) could mean that Natural Gas becomes one of the most valuable products from unconventional fossil fuel mining. This naturally leads on to a discussion about venting and flaring as these practices will need to be curtailed if the energy economy moves its preference from oil to gas products. It will also mean more expense at the wellhead - to capture, store and distribute the gas products. Capturing formerly vented or flared Natural Gas offers climate change protection, perhaps an order of magnitude higher than improving vehicle fuel efficiency over the course of the next decade - owing to the high global warming potential of methane. The increase of Natural Gas from deeper oil drilling, and the attempts to make use of this capacity, also means that unconventional gas resources will become progressively less attractive and likely to be abandoned, much as they were decades ago.	Rejected: This is a valuable comment, but space limitations do not permit further elaborations on NGLs etc.
3450	7	24	7	24	20	Include tight gas and tight oil among the list of unconventional hydrocarbons listed	Accepted - tight gas included
3783	7	25				Check carefully data in table. It is hard to believe that the amount of unconventional oil produced by 2010 was 1/7 of the conventional oil.	Noted: Data checked = correct - it all depends on extraction time and definition: North Sea oil once was considered unconventional - now nearing depletion.
10522	7	25				Be consistent on ZJ or EJ as above.	Rejected - Table uses EJ for energy and GtC for carbon contents
9469	7	25	1	25	5	Unconventional natural gas such as shale gas has environmental and technical issues, and its development is not advanced in some areas. As in page 24, it is described that production of Oil-shale is environmentally challenging, issues of unconventional gas also should be described. In a commentary in the American Journal of Public Health, published in May 2011, Finkel and Law point out some issues of shale gas development[1]. They note the following points ;a) toxic mud and fluid by-products from the drilling and fracking as well as spills of oil and gas wastes are not uncommon. Of the more than 8600 abandoned wells in Pennsylvania in 2009 alone, taxpayers paid to plug 259 because of leaking natural gas, oil, and acid mine drainage into the groundwater, surface water, and air, b) fracking has raised concerns regarding the way it may damage underground water supplies, c) soil contamination also has not been addressed fully, and d) little research has been done on the potential adverse health effects of fracking. [1] M.L. Finkel and A. Law (2011) The Rush to Drill for Natural Gas: A Public Health Cautionary Tale, American Journal of Public Health, Vol 101 No. 5 a)p. 784, column 3. b)p. 784, column 4. c)p. 784, column 4. d)p. 785, column 1.	Correct and not only for gas but all unconventional resources- but discussion here not possible due to space limitations

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3782	7	25	13	25	13	Explain in more details what is the meaning of "diminishing energy ratios" in the context of this paragraph.	Rejected: This is a common term in the literature: It is the ratio of usable energy over total energy used for extraction - no space to do this here.
16806	7	25	17			Suggest replacing "a daunting outlook for climate stability" with "providing clear evidence that declining stocks of fossil fuels will not curtail emissions."	Taken into account- text revised.
4079	7	25	19			A line « Total » at the bottom of the table would be nice	Total exists in Table 7.2
11928	7	25	23			It would be wise to mention that uranium and thorium have fissile components (isotopes). Otherwise it sounds like these are just substances. They give off energy from fission.	Rejected - space limitations
16102	7	25	26	25	31	The uranium resource described in this paragraph is clearly very dispersed. In p.26 lines 8 to 9, RE is dismissed on the same grounds. The chapter should be coherent between resources in this respect.	Rejected - text differentiates between conventional and unconventional resources - and defines a current min concentration for economic feasibility of extraction
9240	7	25	34	25	34	Please refer latest edition of the Red Book (2012) if possible.	Accepted - done
10523	7	25	35	25	39	Doesn't seem to match table 7.3 data. 3700EJ at < \$260 /t leaves 3700 of total conventional resources - which is not "vast additional occurrences". Need to clarify.	Accepted & corrected
11926	7	25	6			This sentence, and in fact the entire paragraph, is a repeat of earlier	Accepted - text revised
13483	7	25	1	25	5	Text: "Unconventional natural gas reserves, i.e., coal bed methane (CBM), shale gas, deep formation and tight gas are now estimated to be larger than conventional reserves and resources combined. This does not include potential reserves from gas hydrates. In some parts of the world, unconventional gas already exceeds conventional supplies. In the United States unconventional gas now makes up about 60% of marketed production" I note there is no mention of the high-impact risks of exploiting coalbed methane - including underground fires and explosions. There is also no mention of the questions being put to shale gas producers regarding freshwater and aquifer extraction and the evidence surrounding groundwater poisoning. I would not say that gas hydrates are a "reserve" as there are few production models that are thought of as sustainable or economic. It is true that the United States relies increasingly on domestic unconventional gas production, but it would be useful to include a projection of the timescale over which this can remain true, owing to shale play/field depletion and the decline of more conventional gas fields.	Rejected: Point well taken but no action due to space limitations
13473	7	25	14	25	18	Text: "Since the industrial revolution, fossil fuel combustion released almost 400 Gt C into the atmosphere (Table 7.2). Fossil reserves alone contain two to four times that amount of carbon - a daunting outlook for climate stability." The reserves figures in Table 7.2 are to my mind rather suspect - particularly the one for coal reserves. I suspect that most of the unconventional oil and gas will remain unexploited owing to economic problems, and that, if the recoverable coal reserves are closer to 10 ZJ than 20 ZJ, the total hydrocarbons and coal that will get burned in the next 150 years is closer to the cumulative total of historical production so far - not twice or four times that amount.	Rejected - For coal and lower reserve limits this is correct but with oil and gas the lower range is twice historical emissions (900 vs. 400 Gt C)

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13484	7	25	14	25	18	Text: "For climate change, it is the carbon endowment potentially available for combustion that matters. Table 7.2 also presents the world's fossil resource endowment in terms of its carbon content. Since the industrial revolution, fossil fuel combustion released almost 400 Gt C into the atmosphere (Table 7.2). Fossil reserves alone contain two to four times that amount of carbon - a daunting outlook for climate stability." As indicated in previous comments, I would contend that there is evidence that recoverable fossil fuel reserves going forward are comparable to historical production figures. The "safety limit" for global warming has been set at around 2 degrees C, and for that, only around 500 GtC (Allen et al. 2009) or 565 GtC (Carbon budget 886 GtC (2000-2049) ==> 565 GtC (2011-2049) Meinshausen et al. 2009 doi:10.1038/nature08017 Table 1) GtC more should be added in net emissions by 2050 - the "carbon budget" ("Warming caused by cumulative carbon emissions towards the trillionth tonne", Myles R. Allen, David J. Frame, Chris Huntingford, Chris D. Jones, Jason A. Lowe, Malte Meinshausen & Nicolai Meinshausen, Vol 458, 30 April 2009, doi:10.1038/nature08019, <a href="http://www.fraw.org.uk/files/climate/allen_2009.pdf">http://www.fraw.org.uk/files/climate/allen_2009.pdf</a> , <a href="http://www.mathtube.org/sites/default/files/slides/PRIMA2009-Allen.pdf">http://www.mathtube.org/sites/default/files/slides/PRIMA2009-Allen.pdf</a> ; "Greenhouse-gas emission targets for limiting global warming to 2 degrees C" by Malte Meinshausen, Nicolai Meinshausen, William Hare, Sarah C. B. Raper, Katja Frieler, Reto Knutti, Nature 458, 1158-1162, 30 April 2009, doi:10.1038/nature08017 <a href="http://www.nature.com/nature/journal/v458/n7242/full/nature08017.html">http://www.nature.com/nature/journal/v458/n7242/full/nature08017.html</a> , <a href="http://www.iac.ethz.ch/people/knuttir/papers/meinshausen09nat.pdf">http://www.iac.ethz.ch/people/knuttir/papers/meinshausen09nat.pdf</a> , <a href="http://www.pik-potsdam.de/~mmalte/pubs/Meinshausen_etal_2009_Nature/Meinshausen_etal_2009_GHGTTargets2C_Nature.pdf">http://www.pik-potsdam.de/~mmalte/pubs/Meinshausen_etal_2009_Nature/Meinshausen_etal_2009_GHGTTargets2C_Nature.pdf</a> , Allen, M. R., Frame, D. J., Huntingford, C., Jones, C. D., Lowe, J. A., Meinshausen, M. & Meinshausen, N. "Warming caused by cumulative carbon emissions towards the trillionth tonne". Nature, doi:10.1038/nature08019 (2009), <a href="http://www.nature.com/nature/journal/v458/n7242/full/nature08019.html">http://www.nature.com/nature/journal/v458/n7242/full/nature08019.html</a> , <a href="http://www.fraw.org.uk/files/climate/allen_2009.pdf">http://www.fraw.org.uk/files/climate/allen_2009.pdf</a> ). If economically recoverable fossil fuel resources prove to be comparable to this figure of a maximum "safe" carbon budget, then the 2 degree C carbon target may be possible. However, this level of emissions in such a short space of time would continue to threaten very dangerous climate change, with feedback warming, particularly as Arctic amplification is threatening massive gas release from tundra, permafrost and Arctic Ocean ("Estimating the near-surface permafrost-carbon feedback on global warming", T. Schneider von Deimling, M. Meinshausen, A. Levermann, V. Huber, K. Frieler, D. M. Lawrence, and V. Brovkin in Biogeosciences, 9, 649–665, 2012, <a href="http://www.biogeosciences.net/9/649/2012/">www.biogeosciences.net/9/649/2012/</a> doi:10.5194/bg-9-649-2012, <a href="http://biogeosciences.net/9/649/2012/bg-9-649-2012.pdf">http://biogeosciences.net/9/649/2012/bg-9-649-2012.pdf</a> ) I would like to see some discussion of this possible outcome in the chapter - that recoverable fossil fuels are of the order of the 2 degree C carbon budget, but that global warming may still overshoot it owing to positive feedbacks.	Rejected. See previous comment (13473), not the section for a discussion on safety limits etc.
9227	7	25		27		To integrate both tables and to add the potential of RE the same as the Table presented in AR4 Chapter 4 Energy Supply Table 4.3.1. Whoever, if the suggestion is not accepted to add to table 7.2 the unconventional coal	Rejected - literature does not distinguish between conventional and unconventional coal really. Also coal occurs essentially in a similar state (unlike oil)
4077	7	25	14	25	21	The link between fossil fuels and climate is too short and should be more complete and more explicit	Rejected: this section is on resources.
4078	7	25	17	25	18	Some more information would be useful in the text there. I would suggest to add something like : « In 2010, fossil fuel combustion released 9,1 GtC in the atmosphere, accounting for x % of global GHG emissions. This can be compared with the annual absorption capacity of the Earth of x GtC. Fossil reserves alone contain x times more carbon than can be released in the atmosphere in a 450 stabilization scenario. »	Rejected: space limitations do not allow the discussion suggested

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13197	7	25	22	26	26	Not mentionig the possibilities open by the breeder reactors is misleading. This omission must be corrected.	Accepted- text revised.
11927	7	25	23	25	23	Misleading. Obviously not all concentrations are "minute". Say that some concentrations are 50x average or more.	Accepted - Done
13485	7	25	26	25	29	Text: "The theoretically available uranium in the Earth's crust has been estimated at 100 teratonnes (Tt) uranium of which 25 Tt occur within 1.6 km of the surface (Lewis, 1972). The amount of uranium dissolved in seawater is estimated at 4.5 Gt. Without substantial R&D efforts, these occurrences do not represent practically extractable uranium." This assessment of the practical recovery of uranium from dispersed resources - especially as regards seawater - is much more reasonable than the over-optimism of Professor David MacKay in his work "Sustainable Energy Without the Hot Air" ( <a href="http://www.withouthotair.com/">http://www.withouthotair.com/</a> , <a href="http://www.inference.phy.cam.ac.uk/withouthotair/c24/page_162.shtml">http://www.inference.phy.cam.ac.uk/withouthotair/c24/page_162.shtml</a> )	Noted
16105	7	26				This table is not sourced and is fairly contradictory with such sources as the CEA (Commissariat à l'Energie Atomique) of France, which suggests much smaller reserves of uranium and pleads for breeder reactors.	Rejected - Table source is NEA Red book. FBRs have been justified on the ground of U scarcity - a flawed argument (table deleted du to space limitations)
16107	7	26				Most of the table 7.3 is speculative, because it rests either on the full closure of the uranium cycle, not even achieved in France, or on a thorium cycle, not even described yet.	Rejected: space limitations do not allow the discussion suggested
16103	7	26	1	26	14	These lines contradict somewhat the previous paragraph that tended to take seriously the marine resource of uranium.	Rejected - terrestrial Th has not been considered "seriously" at present - so why would one consider seawater Th?
3390	7	26	15	26	23	I am not an expert on nuclear, but it seems that lithium-based nuclear power should not deserve such a long pargraph compared to the similar space given to more mature resources (lithium it's not even mentioned in Table 7.3). Perhaps this is a sign of lack of expertise on nuclear in the author's team?	Accepted - paragraph deleted. Information on Li too sketchy - hence not listed in Table 7.3
16106	7	26	15	26	23	Fusion is not a serious option in the timeframe of mitigation. This paragraph should be skipped and replaced by a mention that fusion energy is not to be seriously available in the next century. The paragraph contradicts also the absence of fusion in the rest of the chapter. The only mention should be in the policy sections, because the very high spending on fusion research hampers other developments, be they in nuclear or in renewables.	Accepted - text deleted
13292	7	26	15	26	23	While lithium is a potential source of nuclear energy it is (at least for the foreseeable future) also essential in the manufacture of batteries for electric vehicles. It is worth mentioning this competition, with estimates of the relative quantities of lithium required for each, given that EVs are a major option for decarbonisation of the transport sector	Rejected Comment correct - paragraph on Li deleted due to space limitations
13293	7	26	15	26	23	Much of the identified lithium resource - at least in Argentina, Bolivia and Chile - is in the form of pristine salt flats. There are significant environmental implications of exploiting a large proportion of these reserves, which probably ought to be mentioned	Rejected: Comment correct - paragraph on Li deleted due to space limitations
16807	7	26	15		23	Providing some context re how soon this tech will be available would be helpful -- it seems to me this is not a ready technology, even w/in a decade or more.	Rejected - discussion on fusion technology out of scope here (text deleted anyway)

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2584	7	26	27	28	14	The text underestimates the potential that could play renewable energy combined with energy efficiency in supply sustainable energy. If we take EU target by 2020: 20% energy efficiency and increasing renewables part to 20%, I, objectively that this will lead to less GHG emissions. Although, the fact that some countries would reduce the use of nuclear energy might not impact the current trends of GHG. Even in China, renewable energy are developing fast, and due to the technological progress, renewable energy will be soon the cost effective among energy sources.	Rejected - this section focuses only on technical potential; scenario literature and costs are addressed elsewhere in the chapter and AR5, so this comment is best addressed elsewhere
3391	7	26	28	28	14	Poor section with odd references to support simple ideas. Since there is an IPCC SR on RE it should be easy to rewrite, focusing on key messages from the SR. Avoid rethoric and unnecessary refernces (like in page 26 line 32 to page 27 page 8) or line 3 to line 11 in page 28 (that says the same that the last sentence)	Rejected - this section largely derives from some of the main themes in the SRREN, and many of the references are to the SRREN and its various chapters. The comment does not provide any details of what other / different information is desired from the SRREN or elsewhere.
18206	7	26	28		35	Comments: Hydraulic energy" is kinetic energy of water, flowing from a higher to a lower position, due to gravity. "Bio-Energy" is energy stored in biomass by photosynthesis, then extracted by different means. Comments: The RE potential is constantly available, provided you uses the means (economic, technological and other) adequate and sufficient to achieve its utlization. Knowledge and progressive practice with RE allows its deeper and better use. Comparing (with obvious restrictions) exploitable or Available potential of RE – REA (eg expressed in MM boe/yr) with proven reserves of fossil fuels, such amount (REA) will be available each year that passes, eg for 30 years (life average of a power plant). This explains the concept of available potential of RE, its magnitude and the difference with fossil energy reserves.	Rejected - We agree with the comment in many respects. However, hydro and bio energy rely on secondary forms of solar energy: we use the same definition of renewable energy as used in the special report, so we do not wish to deviate from that recent reference. We note in footnote 10 the need to extract RE at a rate that is lower than the rate of replenishment. It is not otherwise clear what changes the comment is seeking on the text, and we are not able to expand the text due to space constraints.

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18207	7	26	28		35	<p>Alternative paragraph:                      7.4.3 Renewable energies (RE).                      The sources of RE are thermal energy coming from the Sun, and it's interaction with the Earth's rotation, driving the air layers of the lower atmosphere, the water masses of the ocean, and the water circulation cycle in the atmosphere, allowing the use of solar, wind, ocean and hydraulic energy. Bio-energy is the use of energy stored in biomass by photosynthesis*. Geothermal energy is obtained from water and gases in reservoirs recharged with water from the surface, heated by the much higher temperature of magmatic rocks arising from deeper levels in the Earth's crust. In a realistic and practical sense, we can consider the available potential of RE, which depends not only on technologies or practices, but also on other critical and essential factors like social, economic and land use needs, possibilities and constraints, along with the technological level, because the available potential is the result of the interaction of all the above mentioned factors. Technical potential, as defined in Verbruggen et al. (2011) depends only on technologies and practices; nevertheless, the total global technical potential for RE as a whole is substantially higher than current global energy demands. Figure 7.9 summarizes the ranges of global technical potential for the different RE sources. A variety of practical, land use, environmental, and/or economic constraints are sometimes used in estimating the technical potential of RE. Definitions of technical potential therefore vary by study (e.g., Aviel Verbruggen et al., 2010), as do the data, assumptions, and methods used to estimate it (e.g., Angelis-Dimakis et al., 2011). Also important is the regional distribution of the technical potential. Though the regional distribution of each source varies (see, e.g., IPCC, 2011a), Fishedick et al. (2011) report that the technical potential of RE as a whole is at least 2.6 times as large as 2007 global primary energy demand in all regions of the world.</p>	Rejected - we find the current text to be clear as stated, and very directly related to the text included in the SRREN
10524	7	26	30			Could add: .....bioenergy "and biofuels", ....	Rejected - as used in this chapter, and the SRREN, biofuels are a component of bioenergy. We do not think it is needed to reiterate that here.
9990	7	26	30	26	31	RE should be defined to include "aero thermal energy" that can be used with heat pump. RE is defined to include "aero thermal energy" based on the EU direction of "Promotion of the use of energy from renewable sources" and Japanese Law of "Sophistication of Energy Supply Structures".	Rejected - we need to stick with the SRREN for this purpose, to be consistent with previous IPCC reports, though we acknowledge that different definitions do exist. There is no single "right" definition here, so we opt for consistency with the most recent IPCC report
16108	7	26	32	27	13	Estimates for RE technical potentials are clear, uncertainties are explicit and referenced. This is unlike the nuclear part, in particular table 7.3	Rejected: Table deleted - space limitations do not allow the discussion suggested

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2828	7	26	32	27	34	The discussion of renewable potential should be clearer about the fact that most of the studies examined do not consider economics – most of the quoted renewables potential is not directly comparable with the figures quoted for fossil fuel reserves and this should be noted.	Accepted - A number of the potential studies do in fact include actual or proxies for economic conditions when establishing resource potential, in part to distinguish between theoretical and technical potential. But these restrictions vary widely by study, as already noted in the text. As for fossil energy, the same levels of inconsistencies often exist, one reason that the distinction between resources and reserves is not always precise. We made one change to the text, and that is to note that the resource potential numbers for RE are not strictly comparable to fossil and nuclear because of different assumptions across technologies, and among studies, including on economic parameters.
4809	7	26	32	26	35	Remove the sentence on theoretical potential to reduce the size of the chapter	Accepted - removed
4643	7	26	33	26	34	“Because the theoretical potential does not take into account energy conversion losses or deployment barriers, the theoretical potential is of relatively little practical use”. This should not apply to biomass.	taken into account - the discussion of theoretical potential has now been eliminated, due to space constraints
10525	7	26	33			IPCC 2011b - the SPM - is a better reference here than just Chapter 1 of that SRREN report	Rejected - most of the details about theoretical potential for RE are included in Chapter 1 of the SRREN, so if a reader wants to understand that literature Ch. 1 is the place to go. The SPM certainly says what we have said here, but it is not the source of the actual information to defend the statement. Regardless, in the end, due to space constraints, discussion of theoretical potential has been eliminated, and focus is now only placed on technical potential.
16104	7	26	7	26	14	Thorium is described without reference to any practical reactors being developed, there or elsewhere in the chapter. It is not helpful to list it as a resource (for what?)	Taken in to account: Text deleted due to space limitations
4106	7	26	7	26	14	Further detail by country should be given, to include research and investments in India, China, the USA, etc. as well as such data that do exist on the resource base - which is far larger than implied here. This sub-section seems to show a bias.	Rejected - space constraints do not allow to go into the details here.

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11851	7	26	7	27	14	I think thorium (and perhaps lithium) should be introduced a bit better. Uranium is well-known as a source for nuclear power, but less so thorium and lithium. As a side note - this entire section (7.4) is written very nicely. Much easier to follow than preceding and following sections and concisely written! However much of what is covered seems common knowledge (i.e. reserves, reserves base, etc.), and not just here, but throughout the chapter it is hard to tell what the goal of the chapter is - to review all the background, or to point out new information (as compared to AR4 and preceding reports)...not all sections are equivalent in this respect	Agree with comment - but texts on Th and Li deleted due to space limitations
6425	7	26	8	26	8	"virtually every continent of the world..." there are only 7 continents, and this statement implies that the presence of thorium is quite extensive but its precision is vague. Can this be tightened?	Accepted - text deleted due to space limitations
18204	7	26	9		10	Add to paragraph: (9) Reserves and resources of uranium are based on a one-through fuel cycle operation. Closed fuel cycles and breeding technology could would increase the uranium resource dimension 50–60 fold. But these “breded” radioactive fuels represent a much greater contamination problem, in terms of use and storage. (10) In practice, RE sources are sometimes extracted at a rate that exceeds the natural rate of replenishment (e.g., traditional biomass, geothermal energy). Most, but not all, RE sources impose smaller GHG burdens than do fossil fuels.	Rejected: Comment correct - but space limitations prohibit this level of discussion.
18205	7	26	9		10	Alternative paragraph:(9) Reserves and resources of uranium are based on a one-through fuel cycle operation. Closed fuel cycles and breeding technology could increase the uranium resource dimension 50–60 fold. But these “breded” radioactive fuels represent a much greater contamination problem, in terms of use and storage. (10) In practice, RE sources are sometimes extracted at a rate that exceeds the natural rate of replenishment (e.g., traditional biomass, geothermal energy). Most, but not all, RE sources impose smaller GHG burdens than do fossil fuels.	Accepted - text revised.
6187	7	26				This section, and those that follow, have a number of places for potential cuts. Paragraphs spent on describing the availability of fringe nuclear fuels that exist mostly in labs could be shortened or cut entirely, as their contribution to the overall goals are miniscule.	Taken into account - text has been reduced considerably.
9262	7	26				Under renewable energy you could comment on the ability to store it by using excess green energy to pump compressed air into subsurface reservoirs for use when the sun doesn't shine, wind stops, or there's peak demand etc. It's not common, but has been done for decades. Also comment on risk of deploying solar, wind and hydro during changing weather patterns due to climate change - requires forecasting to be correct. - maybe just refer reader on to 7.7.2?	Rejected - these issues are important, and are covered elsewhere in the chapter and need not be included here as well

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4107	7	26	27	28	14	This whole section, though very important for the Assessment, is extraordinarily short and weak. The bland reference to the theoretical potential is far too generalised. There are severe limits on all forms of RE except CSP + UHVDC transmission taking a global perspective. At the regional level, taking into account latitudes and solar insolation, mean wind speeds, the presence or absence of large tidal ranges and wave movements as well as geothermal potential, need all to be taken into account. Belatedly, people are now awakening to bioenergy/biofuel constraints for many purposes and locations. There is reference to the technical potential for solar (p. 27, line 12) without differentiating between solar PV and CSP, and/or where solar PV systems can be optimally located and for what purposes. The brief reference to region potential (p. 27, lines 21-24) scarcely begin to face up to the challenges and differences. The bland statements on global and regional potentials (p. 27, lines 25-27) fail to address the challenges of low power densities, intermittency, etc. The reference on p. 28, lines 1-2, to wind energy potential and its treatment in the IPCC Special Report is jejune. The UK's official planning guidance (PPS 22, Companion Guide, page 165) claims that wind energy developments in the UK typically achieve a load (or capacity) factor of 30% with a range of 20% to 50%. In fact data from the wind energy developers themselves for onshore developments in England over the past five years demonstrate that the average has been 22% (in 2010 down to 18.7%), and the range 4% to (in one case in the exceptionally windy year of 2008) 49%. Graham Sinden claimed back in 2007 that 35% would rapidly become typical. There is no evidence of that happening. The issue of intermittency is also very important, both from the point of view of the need for traditional source back-up, but also because hopes that - for example - if it is windy to the West or South of the UK this would back up where there was a lack of wind for offshore facilities to the East or North. Research evidence shows (eg. Oswald et al) that if it is calm in one nearby maritime area it is highly likely to be calm elsewhere offshore in that region.	Rejected - space constraints preclude a detailed discussion, but we provide links to the SRREN, which addresses issues of technical potential in more detail. This section also only addresses technical potential (not market/social/realistic potential, considering various constraints), while linking to other sections of the chapter that address scenarios/integration/ and the various constraints and opportunities for the use of RE. Those matters are best addressed in other sections of the chapter, not here. The same approach is used in discussing the potential for fossil and nuclear: we are not judging what is possible or likely in these sections, only how much resource there is. As such, this subsection's approach is consistent with those of others in 7.4.
7731	7	27				Figure unclear. Suggest to improve resolution of it.	Accepted
4434	7	27		27		Figure should be re-drawn for clarity	Accepted
10066	7	27				It should be made more clear that the RE potentials are annual potentials	Accepted
4645	7	27		27		The total primary energy consumption for 2009 is given as 492 EJ. The technical range for biomass is given as 50 EJ to 500 EJ. According to IEA, the biomass primary energy consumption for biomass is 10.2% of the total or 50 EJ. If wood consumption for non-energy uses is included, then this total is increased to about 72 EJ. Thus, the lower estimate of 50 EJ may have already been achieved.	Rejected - The IPCC report addresses this issue, and we do not have the space to reproduce the argument here. It is a good point, and for biomass, depends critically on the definition of technical potential.
15944	7	27		27		For wind energy potentials see the recently published - Nature Climate Change; 'Geophysical limits to global wind power' Kate Marvel, Ben Kravitz & Ken Caldeira ; and PNAS 'Saturation wind power potential and its implications for wind energy' Mark Z. Jacobson,1 and Cristina L. Archer,1 Nature Climate Change (2012) doi:10.1038/nclimate1683 Received 01 May 2012 Accepted 08 August 2012 Published online 09 September 2012	Accepted - The figure is included in the SRREN, and is not planned for an update for the AR5. We have reviewed these citations for inclusion in the text, however, and have included one of the two.
12157	7	27		27		It's very important to improve the quality of the Figure 7.9. after all, it's difficult to understand well some information.	Accepted

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16809	7	27	1	28	14	Just as in previous section's discussions of resource availability of fossil fuels, renewable energy sources have similar economic limits, i.e., some amounts are available at relatively low costs and some at a much higher cost. The supply curve slopes upward and to the right. Example: Some wind energy sites are ideal -- close to electric transmission and with good wind. As you move away from this optimal site, the costs increase (or productivity declines) -- the site may yet be fine, but it is not as good as the optimal. In a world with a carbon price, you would develop the optimal site first and may not develop the less optimal site until later when carbon price had increased.	Noted - this point is addressed later in the section, at least briefly
9645	7	27	13			Figure is blurry and difficult to read	Accepted
12597	7	27	25			It is interesting how the EU27 shows that financial wealth and renewable resource wealth (such as the UK) does not equate to high levels of renewables. To take the UK example further, looking at data from www.energy.eu, the UK is number 25 in the EU27 for renewable energy penetration, a surprisingly low position.	Noted - Does not appear that this comment suggests a textual change
18208	7	27	25		29	Alternative paragraph: As estimated by this literature, the global and regional technical potentials for RE as a whole are unlikely to limit deployment. Further, as with other energy sources, all else being equal, continued technological advancements can be expected to increase estimates of the technical potential for RE in the future, so as improvements in energy policy, planning and R&D&D, internalizing the environmental, land-use and social advantages of RE, reflected by its available potential, in the general frame of all the viable energy options, be it at sub-continental, national or regional level.	Rejected - Unnecessary detail for a section this is already at its page limit
4644	7	27	9	27	10	This statement points to the urgent need for reliable land use maps and inventories. This cannot be over-emphasized.	Noted - does not seem to suggest an actual textual change
3394	7	28		29		Simplify discussion around Figure 7.10. Well known ideas and I guess few changes respect to AR4. No need for so many new references unless they are supporting key numbers in Figure 7.10. Preferably, you should use references from major reports.	This section tries to address both new findings related to fugitive emissions of methane especially from natural gas systems, opportunities for reductions of these fugitive emissions from all fossil systems, and the existing fuel switching strategy. While fuel switching is discussed in AR4, the new findings listed here show that the issue is not quite as simple because gas-fired power plants can have higher GHG emissions than implied by AR4 due to both fugitive emissions and if liquefaction of NG causes high emissions.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
3272	7	28		37		Section title of 7.5 is "Mitigation technology options, practices and behavioural aspects", but there is little description of behavioural aspects in this section.	Accepted - important behavioural aspects in the field of energy consumption are to be discussed in the demand chapters. In chapter 7 behavioural aspects are addressed in 7.6 (e.g., demand response) and 7.9 (risk perception) and 7.12 (e.g., investor behaviour). Pointers to these chapters are included in 7.5.
10528	7	28	11			... of the biomass resource (de Vries et al., 2007)." Delete "e.g" from in front of references.	Accepted
12589	7	28	12			One thing which also helps acceptance is joint ownership of the energy systems. If a system is owned by a community, they are much more supportive of it	Rejected. While the argument has merit, we do not have space to get into this argument.
12590	7	28	12			There are issues with disinformation on renewable energy systems. Some of this is perpetuated by organizations which do appear from the outside to be fair, neutral sources. The Renewable Energy Foundation in the UK is a good example of this.	The comment seems to be misplaced.
2971	7	28	15			The "behavioral aspects" are missing in this section.	Rejected. This section addresses the emissions from the well/mine to electricity, heat, or refinery gate. Behavioural aspects may be important regarding the management of the chain and especially fugitive emissions, but no literature has been found on this issue.
5954	7	28	15			Sections 7.5 and 7.6 provide excellent summaries of current technology and infrastructure performances in relation to consideration of future mitigation. However, it would also be worthwhile to include a brief summary of advanced laboratory research developments, including use of nanotechnology, that have the potential to fundamentally restructure energy production and provision.	Rejected. First, we need to base the assessment on technologies that have been demonstrated in order not to mislead policy makers. The technologies must have been assessed in the peer-reviewed literature. Second, this would not be possible within the space available for discussing technologies.
4814	7	28	15	28	15	Include assessment of demand side management (smart grids/meters, energy efficiency measures, storage, etc) to the list of mitigation options	Rejected - though not from the perspective of resource potential, storage and DR issues are addressed in a later section. We have forwarded this comment to the relevant authors of the later section.
3393	7	28	17	28	19	Is this the place to remember that fossil fuels are a major cause of anthropogenic climate forcing...?. Delete full paragraph	The section also addressed the emissions from fossil fuel production, which were not covered anywhere else. This is now included in the discussion of emissions inventories in section 7.3

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10529	7	28	18			Rest of chapter / report uses Gt, not Pg so suggest change to be consistent	Taken into account - comment is obsolete. Underlying text has been deleted.
10526	7	28	2			Why only wind chosen here? Suggest delete the wind reference and just leave Verbruggen et al, 2011 - and delete "generally".	Accepted
9646	7	28	20	28	20	add "oil and gas" before wells and pipelines or it sounds like it is coal wells and pipelines.	Accepted. Language changed.
3784	7	28	20	28	20	Check the figures in "(0.3 PgCO <sub>2</sub> , 1-28 PgCO <sub>2</sub> e CH <sub>4</sub> )"	Taken into account - sourced checked. The numbers are correctly reproduced. Please note this paragraph has been deleted and information is now covered in section 7.3.
3785	7	28	20	28	24	Improve Figure 7.10 adding information on technologies required to reduce GHG emissions shown	Taken into account. Note that the original figure was not reproduced correctly in the FOD. CCS is included. Other emission reduction opportunities were not shown. They are potentially more difficult as many of the listed opportunities have not been systematically researched in terms of their effectiveness.
11929	7	28	21			Label missing on abscissa in Figure 7.10.	Accepted. The figure was not correctly reproduced
10530	7	28	22			Not 7.2.3. Maybe quote Section 8.2 better	Accepted.
17364	7	28	26			can be reduced through...	Accepted.
11930	7	28	27			Define distinction between T and D. Which losses? T or D?	Rejected. This comment must be misplaced.
6696	7	28	29	28	37	For sustainable development, we must consider energy security and economic influence. From this standpoint of view, not only replacing existing coal fired power plants by highly efficient natural gas power plants, but also replacing by more efficient coal plants is needed.	Rejected. You are suggesting to introduce a longer discussion of alternatives which we do not have place for here.
11762	7	28	29	28	31	Energy must be chosen taking into not only environment but also economy and energy security. To avoid the misunderstanding, [provided the economy and energy security is not taken into account] should be added after this sentence. Refer to No.4.	Reject. Energy security is addressed in 7.9.1, this section refers to climate mitigation.
10067	7	28	29		30	It should be spelled out that the CO <sub>2</sub> reductions here relates to the emissions during combustion only.	Reject. The review comment seems to be misplaced as specific emission numbers are not presented here.
10654	7	28	29	28	31	Add a statement coal is preferred from the view point of energy security.	Reject. Energy security is addressed in 7.9.1, this section refers to climate mitigation.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9991	7	28	29	28	37	<p>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, 42 Fig14) and (Janos, 2009, page5 and 7-8, Figure1 and Table 1, 2).</p> <p>&lt;Reference&gt;                      [1] IEA (2011). Power Generation from Coal Ongoing Developments and Outlook, IEA Information Paper. Available at: <a href="http://www.iea.org/papers/2011/power_generation_from_coal.pdf">http://www.iea.org/papers/2011/power_generation_from_coal.pdf</a>                      [2] Janos M Beer (2009). Higher Efficiency Power Generation Reduces Emissions, National Coal Council Issue Paper. Available at: <a href="http://web.mit.edu/mitei/docs/reports/beer-emissions.pdf">http://web.mit.edu/mitei/docs/reports/beer-emissions.pdf</a></p>	Taken into account - this was evaluated in the figure 7.10. The missing labelling was corrected for the SOD. The cited literature was taken into account if appropriate.
9368	7	28	29	28	31	Coal fired power plant has potential to reduce CO2 emissions by improvig the efficiency of the plant.(IEA,2011).Thus it should include the view that effective utilization of coal fired power plant is needed for energy security.	Accepted - concerning domestic coal, this comment is addressed in section on energy security (7.9).
13036	7	28	3	28	6	This sentence appears to be a misleading restatement of data on technical potential for RE, and the source supplied does not sufficiently support the assertion of limited RE potential.	Accepted, in part - On a long term basis and under high carbon reduction targets, some technologies have limits on their contributions. We have clarified the statement to make it clear that we are talking about cases in which very deep carbon reductions are sought, and where individual technologies cannot meet huge proportions of total energy supply needs. But in those cases, it is in fact clear based on 7.9. there could be real technical limits in some cases.
18052	7	28	31	28	31	After "(NGCC) power plants" add" renewable energy technologies, efficiency". Without a reference to renewables is seems that the only mitigation options in the power sector is fuel switching from coal to gas and CHP, despit efficiency and renewables being the options with the highest carbon reduction potential in most areas of the world	Rejected. This section addresses mitigation opportunities within the fossil fuel sector. The text is not formulated to suggest that fuel switching is the only way to address emissions.
10068	7	28	32		34	<p>The methane issue should be more elaborated, with respect to the differen GWPs in different timeframes for the different GHGs .</p> <p>See: The future of Natural Gas, E. Monitz et al, MIT (2011);                      Shindell et al, Science 326, 716 (2009)</p>	Taken into account - it has been noted that the 100 y GWP is used. It is an editorial decision of GWIII to utilize GWP100 throughout the report.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2829	7	28	34	28	37	The discussion of LCA here is out of place and over-compressed and this sentence (and probably the whole paragraph) could be omitted – there is a better treatment in 7.8.1. In any event, the referencing at both points is odd. Singh et al 2011 is about CCS technologies so it is not clear why it is used as a reference for conventional generation – on which it takes its figures from the Ecoinvent database, which reflects historical European conditions. The discussion should point out that LCA figures are situation specific and depend on the underlying assumptions, so that quoting any single figure is misleading. In the comparison cited here, there is also an odd mixture of average and marginal data. While this is made clear in relation to the technology, it is not clarified in relation to the supply source. The natural gas-related emissions on which the comparison is based are based on the situation in Europe nearly a decade ago. For a new NGCC emissions would depend on the assumptions about the gas source – Russia? Qatar LNG? US shale gas LNG exports ? – all of which would give very different results, especially given the uncertainty about methane emissions in transmission from Russia, which alone could completely overturn the conclusion.	Accepted. We have updated the analysis using more recent emissions estimates for fugitive emissions from Burnham et al. The LCA appropriately combines different sources of emission. In this section, we systematically emphasise the importance of fugitive emissions during fuel production and emissions associated with gas transport, which may make fuel switching less attractive than when addressing only power plant emissions. We would appreciate references for emissions from the gas sources cited here, but as long as those emissions do not come from a peer-reviewed paper, we find it hard to consider them.
11852	7	28	36	28	37	Why is only one value and one data source reported for Coal vs NGCC (Singh et al 2011)? There are numerous LCA studies with varying estimates (e.g. - and this list is not exhaustive - Burnham, A., et al. Life-Cycle greenhouse gas emissions of shale gas, natural gas, coal, and petroleum. Environ. Sci. Technol. 2012, 46, 619-627; Argonne National Lab's GREET 2012 Model; Jaramillo et al. Comparative lifecycle air emissions of coal, domestic natural gas, LNG, and SNG for electricity generation. Environ. Sci. Technol. 2007, 41, 6290–6296; etc. ).	Taken into account. Please note that the findings from the paper by Jaramillo et al are cited. The Burnham paper was not available at the time of writing. The figure has been updated taking the fuel chain emissions from Burnham.
17222	7	28	37			The carbon intensities are not the default values recommended by IPCC and used by IEA. The CLAs are strongly requested to check these numbers.	The numbers are sourced from the IPCC database following 2006 guidelines. Anthracite: EF-ID 117627; natural gas: EF-ID 117642
11853	7	28	37	28	38	Why is the carbon content of anthracite coal listed? Anthracite is most typically used in metallurgical processes, not power generation. Anthracite has a high carbon content compared to, for example, bituminous or sub-bituminous coal (more typical for power generation).	Accepted. Has been replaced by sub-bituminous coal, which has a carbon content of 26.2 g/MJ compared to 26.8 for anthracite.
6448	7	28	37	28	38	Note that anthracite is not the major coal type used in electricity production; this sentence should include data for sub-bituminous coal which is much more widely used for electricity production	Accepted. Has been replaced, see response to comment 11853.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5153	7	28	4	28	4	how do this claim match the deployment predictions of ch 5 in the SRREN where Hydro may increase from 3000 to even 9000 TWh in 2050 - the sentence hints that there is not much hydro to develop	Accepted, in part - On a long term basis and under high carbon reduction targets, some technologies have limits on their contributions. We clarified the statement to make it clear that we are talking about cases in which very deep carbon reductions are sought, and where individual technologies cannot meet huge proportions of total incremental energy supply needs. But in those cases, it is in fact clear based on 7.9. there could be real technical limits in some cases.
16036	7	28	41	28	42	Further emissions reductions maybe possible through CO2 Capture and storage and CO2 Capture and use for example through algae	Rejected. No reference provided to evaluate this option.
5134	7	28	42		45	The sentence is not clear. What specific message the statement is trying to convey?	Accepted. Change to: "If gas is liquefied with a dirty power source and shipped over long distances, It should be noted that, depending on specific circumstance of fuel production, liquefaction and transport, the range of life-cycle GHG emissions of electricity generated with LNG can be significantly closer to the emissions from current coal technology."
10527	7	28	5			Are solar and wind really "seemingly more-abundant"? Not shown by technical potential analysis of scenarios in Chapter 10 of SRREN.	Accepted - more abundant based on technical potential alone (not scenarios). This have been clarified.
4646	7	28	9	28	11	"Competition for land --- may impact on aggregate technical potentials, as might concerns about the carbon footprint and the sustainability of the resource (e.g. biomass) ---". This should not apply to woody biomass from existing sources as its NPP is far in excess of current demand.	Rejected - the word "may" provides the appropriate caveat here
4779	7	28	3	28	6	The sentence "may be limited by the available technical potential, e.g., hydropower, bioenergy, and ocean energy" is not correct. As stated in IPCC/SRREN report the untapped technical potential for those 3 technologies is still huge, refer to Figure 7.9 for instance.	Accepted, in part - On a long term basis and under high carbon reduction targets, some technologies have limits on their contributions. We have clarified the statement to make it clear that we are talking about cases in which very deep carbon reductions are sought, and where individual technologies cannot meet huge proportions of total energy supply needs.

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6188	7	28				This section is in general detailed, well-written, and comprehensible. However, it tends towards listing technologies and providing a brief explanation of them, which isn't quite effective in understanding how they compare to each other. Using tables or other figures as the primary means of displaying information could solve this problem, while potentially reducing the total page count.	There is a figure comparing different fossil fuel options. It is not clear whether the review comment suggests a figure for the entire section 7.5. Please note that a figure indicating potential reductions has been added to 7.8
18508	7	28				An intro paragraph to this section explaining how the options presented in the different sub-sections fit together or complement one another would be useful.	Accepted - an intro paragraph to 7.5 has been introduced.
18514	7	28				Each of the sub-sections (i.e. technology categories) has a different focus and structure, and in some cases topics stray to cover scenarios and risks. Some differentiation is of course necessary because of the fundamentally different nature of the technologies, but some similar structural elements would be useful. For example, an introductory paragraph summarizing the different options available in that category, a paragraph on changes since the AR4 (Section 7.5.4 does this in an exemplary way!), and a paragraph+ for each of the different options including where they've been deployed.	Accepted - issues of risk and scenarios have been removed as they are covered in other sections of the chapter. An introductory paragraph has been added.
13486	7	28	40	28	41	Text: "Emissions associated with NGCC are still too high to meet long-term stabilization targets." This is true if one considers all new Natural Gas combustion plant to be in permanently in operation. However, balancing variable Renewable Energy capacity with Natural Gas as backup will allow for gas power generation to idle. With the growth in different streams of Renewable Gas, net carbon emissions of gas generation should reduce significantly, even if carbon intensity is somewhat increased owing to variable energy values of the Renewable Gas sources. One important condition of new gas plant commissioning should be that the gas turbines are not only efficient, but flexible, or permit retrofit for more flexibility - to allow greater flexibility in the use of new resources of gas - namely Renewable Gas, which is likely to have variable energy density.	Taken into account - specified that this is the case only for use of NGCC for base load power.
13487	7	28	41	28	42	Text: "Further emissions reductions are possible through CO2 capture and storage" It seems to me to be wasteful to burn more gas in order to capture the carbon dioxide and pump it into permanent storage. The time taken to develop widescale carbon capture and storage capacity is going to take much longer than it would take to properly implement fugitive gas capture. (Example reports : "Leaking Profits, NRDC <a href="http://www.nrdc.org/energy/leaking-profits.asp">http://www.nrdc.org/energy/leaking-profits.asp</a> ; "Controlling fugitive methane emissions in the oil and gas sector", IIGCC, <a href="http://www.iigcc.org/__data/assets/pdf_file/0017/15371/Methane-emissions-Statement.pdf">http://www.iigcc.org/__data/assets/pdf_file/0017/15371/Methane-emissions-Statement.pdf</a> )	Rejected. We cannot base our report on the political statements of interest groups.
14703	7	28				Assessment of GHG emission from unconventional gas is large depended on which GWP factor should be used. For examples, Howarth et al., 2011 is using much higher GWP (105 as 20 year and 33 as 100year from Shindell et al.2009) than IPCC 2007(72 as 100 year and 25 as 100year). Therefore the emission is evaluated very high. So the information which GWPs and time horizon are used should be shown in IPCC assessment report.	Accepted - see response to review comment 10068
18509	7	28	16			Section contains good information, but the structure is intermixed, making it difficult for the reader to pull clear messages. Having dedicated paragraphs on the three options introduced: 1) fuel switching; 2) ee; and 3) reducing fugitive emissions would be helpful.	Reject. Please note that fuel switching makes sense ONLY when fugitive emissions from natural gas chains are kept low and LNG plants use clean electricity and LNG ships are well designed and operated at the right speed. These options are not independent and hence cannot be treated independently.

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15485	7	28	18	28	19	Fossil fuel extraction, conversion and fuel switching – add in the brackets data for building and construction sector in the list as they represents around 40 % of the global GES	Rejected. The building and construction sector is addressed in Ch.9
4081	7	28	25	28	28	Total climate forcing has to be reduced. It is not relevant to focus on climate forcing « per unit energy delivered ». I would suggest « Climate forcing from fossil fuels can be reduced through (1) containing the global energy demand (2) higher energy efficiency (3) switching to lower carbon-intensity fuels and (4) reducing fugitive emissions along the supply chain and black carbon emissions from combustion. »	Rejected. While this is absolutely true and the basis for WGIII, this section specifically focuses on reducing emissions in the fossil fuel/power/heat production chain.
9228	7	28	28	28	28	To add "(4) change or switching to economy structure more light"	Rejected. While this is relevant for mitigation overall, it does not fit into this section which deals with the fossil fuel chain and not the level of energy consumption.
11713	7	28	15	30	35	High efficiency distribution generation, especially fuel cells (PEFC, SOFC) has been advanced and already commercialized. It might be effective not only reducing transmission loss but also changing the scale of combined heat and power (e.g. CHP in single home) and scale of energy system (e.g. smart grid). More description on distribution generation is needed.	taken into account - fuel cells now are mentioned in the text.
12326	7	28	15			We recommend adding an introduction that describes the challenge - how much mitigation is needed in the 450 ppm scenarios, and the stabilization scenarios. The danger of "lock-in" should be commented on as this might be quite relevant in regions where the focus is on building a natural gas infrastructure without CCS. (Long term versus short term mitigation needs.) We also recommend moving (a shorter version of) section 7.8.1 to this section 7.5 and moving chapter 7.8 (Costs and potential) immediately after chapter 7.6.	Taken into account - introduction has been added.
12327	7	28	15			Regarding the structure of 7.5: We recommend rearranging the order of the sub-sections to: 1. renewable energy, 2. fossil fuel extraction ... 3. CCS 4. nuclear energy and 5. energy efficiency in transmission and distribution. Reasoning: this latter is relevant for all energy production, and will provide a better transition to Section 7.6.	A common order has been agreed for all the sections of this chapter.
3395	7	29		30		Focus on energy losses figures and avoid detailed technical details about transmission lines operating conditions, clearly out of scope in an IPCC AR report.	On reflection I don't accept this - the text was to be shortened and has been slightly revised, but note that examination of mitigation requires some idea of where the losses occur.
4435	7	29		29		A y-axis with numbers is needed for this figure.	Taken into consideration. The figure has been revised (now figure 7.8)
16110	7	29				No scales given. Even with the right scale, this figure is misleading, because the thermal plants will not usually be used as baseload, and their emissions will depend on the rest of the system.	Taken into consideration. The figure has been revised (now figure 7.8)
14542	7	29		29		Figure needs to be fixed	Taken into consideration. The figure has been revised (now figure 7.8)
9591	7	29				Please, add name on each bar chart and calibrate unit.	Accepted. Figure has been corrected.
4522	7	29				I do not understand this figure? Is there a label on the x-axis that is missing?	Accepted. Figure has been corrected.
6230	7	29				no distinction between coal & gas	Accepted. Figure has been corrected.
15945	7	29		29		there is no identification of the X axis in this chart	Accepted. Figure has been corrected.

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10531	7	29				Explain the arrows with -19%, -16% -80% of what? Need x axis labels.Add data to y-axis. Explain probability bars Delete "(BAT)"	Accepted. Figure has been corrected.
10048	7	29				Legend unclear - different technologies should be included in the x-axis	Accepted. Figure has been corrected.
14702	7	29	12	29	13	There are other analysis for life cycle GHG emission assessment for unconventional natural gas. Their analysis is summarized as follows; 1)Fugitive emission from shale gas well completion with hydraulic fracturing is much smaller than the emission from gas combustion at final demand. And the fuel combustion of natural gas is much smaller than that of coal. Therefore, the emission from shale gas is much smaller than coal by LCA. Reference cited; National Energy Technology Laboratory 2011(Life Cycle Greenhouse Gas Inventory of Natural Gas Extraction, Delivery and Electricity Production), Shell Global Solutions (U.K.), Shell Technology Centre Thornton 2011(Modeling the Relative GHG Emissions of Conventional and Shale Gas Production). 2)Furthermore three is the report which points out that emission from shale gas is smaller than conventional natural gas because shale gas does not need liquid unloading. Reference cited; Argonne National Laboratory 2012 (Life-Cycle Greenhouse Gas Emissions of Shale Gas, Natural Gas, Coal, and Petroleum).	Taken into consideration. Note that there are competing views on this issue. See for example review comment 13488 and the references cited therein. We are surveying this emerging field and attempt to consider all findings and perspectives.
5135	7	29	16			Replace 'tar sands" with "oil sands"	Accepted. Replaced.
9647	7	29	19			No axis labels on the chart	Accepted. Figure has been corrected.
9270	7	29	20			Need to add actual units of measurement to Y axis (i.e. intervals of x kgCO2-e)	Taken into consideration. The figure has been revised (now figure 7.8)
4082	7	29	20			This figure lack of legend for histogram bars	Accepted. Figure has been corrected.
15465	7	29	26	29	31	We can add the fact that in the US, the combined transmission and distribution losses in the US are much higher at 14.9% in 2010. See reference: page 10 of <a href="http://www.americanprogress.org/wp-content/uploads/2012/08/0709_CleanEnergyWeb2.pdf">http://www.americanprogress.org/wp-content/uploads/2012/08/0709_CleanEnergyWeb2.pdf</a> or US EIA Annual Energy Review, 2012	Rejected as the I don't believe that such focus on US data is appropriate, and actually the IEA give 6% losses fore the US in 2010 so there appears to be a consistency issue here too.
4810	7	29	26	29	27	Add a line on the rationale for transmission losses being less than distribution losses. Does this apply to all countries? I would think that countries such as Brazil where most of the generation is located far from consumption would have more transmission losses compared to distribution, than countries where generation is close to consumption. Or is this losses by km instead of system losses?	Accepted. Text amended.
10532	7	29	26			Deelete "are known as transmission losses, they" and add "high-voltage" transmission system and "low-voltage" distribution system. Delete "(distribution losses)".	Accepted
9648	7	29	28	29	31	Seems outdated - is there more recent data? A comparison with non-OECD countries would be useful.	Accepted - text revised.
10533	7	29	28			Change "energy delivered" to "electricity delivered". But below is the 6.5% losses of electricity delivered or electricity generated? I suspect the former. Need to clarify in text	Accepted and dealt with
16811	7	29	3		6	When discussing emissions from the energy use in fossil energy extraction, do we risk double counting emissions if we include these in emissions from fossil fuel use, as it typically done?	Taken into account. Please note that a consistent life-cycle methodology ensures that each emission is counted only once.
4436	7	29	30	29	31	This transmission+distribution losses figure should be updated.	Accepted and dealt with as far as possible.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18510	7	29	30	29	31	Is there not a more recent reference? At the time the AR5 is published, this reference will be more than 10 years old.	We are running with IEA 2003 until we have something better that is properly published. Suggestions welcome.
14543	7	29	6	29	6	Consider adding " and ocean thermal energy conversion has significant potential for providing base load energy for small island state". Although small islands are minor emitters, they also need to take mitigation more seriously, and be aware that RE such as OTEC can provide energy independence.	Taken into account. A box on developing countries and LDCs was included.
16037	7	29	9	29	11	to much sources	Rejected.
13488	7	29	12	29	13	Text: "Fugitive emissions associated with unconventional gas production are controversially discussed (Howarth et al., 2011; Cathles et al., 2012)" Additional papers : "Methane Emissions from Natural Gas Systems", Robert Howarth, Drew Shindell, Renee Santoro, Anthony Ingraffea, Nathan Phillips, and Amy Townsend-Small, February 25, 2012, Background Paper Prepared for the National Climate Assessment, Reference number 2011-0003, <a href="http://www.eeb.cornell.edu/howarth/Howarth%20et%20al.%20-%20National%20Climate%20Assessment.pdf">http://www.eeb.cornell.edu/howarth/Howarth%20et%20al.%20-%20National%20Climate%20Assessment.pdf</a> ; Howarth et al. 2012, "Venting and leaking of methane from shale gas development: response to Cathles et al.", Climatic Change, DOI 10.1007/s10584-012-0401-0 <a href="http://www.eeb.cornell.edu/howarth/Howarthetal2012_Final.pdf">http://www.eeb.cornell.edu/howarth/Howarthetal2012_Final.pdf</a>	Taken into account. Please note that fugitive emissions of methane is an emerging issues also for coal. There is a lot of work that is coming out and we are keeping an eye on this. However, we are trying to get a balanced view and we see at this point no basis for endorsing one or the other of the competing views.
13490	7	29	20	29	24	This figure is missing the horizontal axis.	Accepted. Figure has been corrected.
13489	7	29	40	29	42	Text: "Emissions associated with NGCC are still too high to meet long-term stabilization targets. Further emissions reductions are possible through CO2 capture and storage (Section 7.5.3)" Carbon Capture and Storage is possible, but the question remains as to whether it is probable. Although on a very local level it is already being employed, it is difficult to imagine incentives for widescale use, considering its implications for added combustion of fuel, and the construction of a parallel infrastructure to gas grids. It is unlikely to happen in developing countries, who lack infrastructure-building capacity. Whilst it is true that Natural Gas Combined Cycle emissions are too high to meet long-term stabilisation targets, if they gradually become back up to renewable energies, such as widespread wind and solar power, and if gas supplies become decarbonised through increasing proportions of Renewable Gas (Renewable Hydrogen and Renewable Biomethane, principally), there is no reason to doubt that gas generation will continue to be useful and fall within any low carbon regime.	Rejected -- no scientific evidence / publications are provided to substantiate the reviewer's opinion. The reviewer is expressing their personal opinion. It is difficult to respond to a generic statement that "it is hard to believe" without some substance behind the comment or specifics about what should be changed in the text.
15355	7	29	25			This section could be strengthened through incorporating information on energy efficiency in other areas for example demand sectors such as industry (boilers etc), buildings, transport, as the energy balance and other sections refer to significant consumption, low efficiencies as well as there being high potential for savings.	Rejected - such information is appropriate in this section.
3451	7	29	26	29	31	Are there any updated figures regarding T&D losses?. In the document the figure presented is for the year 2000	Is IEA 2003 the latest published figure? I have added a ref to online IEA data for 2010.
11931	7	29	27			Energy intensive?	Unclear what is intended by this comment - the use of the term was fine here.
6240	7	3	13			ince prices determine demand, subsidies bias the price signal, IEA made some investigation in international subsidies in their WEO, role of subsidies in climate perspective should be mentioned in more depth. Especially subsidies in developing countries	Taken into consideration - subsidies are mentioned in 7.12.3
6241	7	3	29			topic of energy taxes is just mentioned but energy taxing might be looked with some higher depth since energy taxing might also help the meet climate purposes.	Rejected - space constraints do not allow to go into the details here.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6239	7	3	3			many mire reports than referenced have been produced on this topic	Rejected - comment seems to be misplaced. It is not clear what the reviewer means. Please clarify.
12586	7	30				There is still much work to be carried out on CCS. Technically yes it is possible, but how commercially possible is it?	Noted. The text as currently written specifically addresses this point when it says "CCS is a technology suite that has the single purpose of capturing and storing CO2 and therefore is not deployed without either limits on emissions..." Given space constraints, there is no need to elaborate further.
4647	7	30		30		CCS. See my notes above.	Comment unclear - as reviewer gave many comments at different places.
4437	7	30	1	30	2	Reference for the assertion of 25% losses from distribution transformers in Europe.	Only grey literature here but I have added a new ref (EU project report)
17281	7	30	1		2	This statement requires a reference	Accepted and done
15486	7	30	1	30	6	Add data for developing countries (Africa Region based on studies on Grid integration) and, if possible, also for transition economies such as China in order to have comparable perspective	A figure for India was added, but to add more due to page constraints and limited value of the additional data is not feasible.
4108	7	30	18	30	25	There could usefully be a more detailed discussion here about work being done, and progress made, on UHVDC transmission, links to CSP and the Desertec concept, developments in California, and potntial to harness wind energy as well over large distances which might offset the criticism immediately above.	Rejected. Since the section is already too long and this is speculative, this was not added.
18053	7	30	20	30	21	"for very long lines" must be more specifically defined. App how many km?	Accepted and dealt with
9470	7	30	23	30	25	This part should be left in this report, as there is possibility that connecting renewable energy to utility grid increases transmission losses.	Accepted - no change required
4438	7	30	23	30	25	Define considerable distances. What losses are predicted for programmes, such as the IEA PV in the desert? There are discussions of a pan-Asian network and pan-Australian network.	Done
16111	7	30	23	30	25	This paragraphe is doubtful, because the losses will depend both on the local resouces such as PV, and the matching of this resource to the electricity usage in the area. Present developments are favourable with such local or even in-house production, the transmission being used in limited hours of the year (thus limiting losses).	Its not doubtful - its precise and logical
11763	7	30	23	30	25	This kind of concern should be recognized.	Accepted - no change required
10655	7	30	23	30	25	Good argument.	Accepted - no change required
5155	7	30	23	30	23	what os meant by "time varying renewable" ? Intermittent or variable ?	The term has been used as it is more precise than the two alternatives offered.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9992	7	30	23	30	25	<p>This part should be kept in SOD because problems of RE are mentioned well and comprehensively. As described in FOD, 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. This information is described in (Quezada, 2006, page 533 and 537)</p> <p>&lt;Reference&gt;                      [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,</p>	Accepted - no change required
9369	7	30	23	30	25	It raises an important fact.	Accepted - no change required
16813	7	30	25			Suggest adding this at end of line: ",which results in increasing relative cost for more remote resources."	Rejected. Not supported by the underlying technical literature. Furthermore, I don't understand what the suggested change is supposed to accomplish.
5136	7	30	26		35	As the losses due to transmission & distribution of electricity have been discussed in the section 7.5.2, this particular section dealing with fossil fuel ( oil & gas) transmission & distribution must discuss the associated energy loss and related energy efficiency issues.	Noted. The point the reviewer is making is not clear.
9649	7	30	26	30	35	this paragraph is out of place - doesn't fit with the rest of the section	I don't see a problem with the paragraph or its placement.
5154	7	30	3	30	6	Sentence starting with "An increase--" - message could be made more easy to comprehend	Accepted and done
2972	7	30	36			A description of the infrastructure needs (pipelines) for CCS should be included.	Taken into account. This topic is discussed in section 7.6.4.
18211	7	30	37		44	<p>All of the components of integrated carbon dioxide capture and storage (CCS) systems exists and are in use today by the hydrocarbon exploration, production and transport; petrochemical refining; and power engineering sectors. A complete end-to-end CCS system would mitigate CO2 emissions by capturing CO2 from large (e.g., typically larger than 0.1 MtCO2/year) stationary point sources, compressing the captured CO2, transporting and injecting the compressed CO2 into a suitable deep (typically more than 800m below the surface) geologic structures, and then applying a suite of measurement, monitoring and verification technologies to ensure the safety, efficacy, and permanence of the captured CO2's isolation from the atmosphere (IPCC, 2005; HJ Herzog, 2011).Comment: As indicated in paragraph this technology is in the experimental stage. The text of this technology as a real and tangible to offer a product that does not exist from the establishment of a broad base theme.</p>	Rejected. Not supported by a compelling body of scientific evidence/publications. The text as currently written in Chapter 7.5.5 is more accurate than this suggested revision.
18212	7	30	37		44	<p>Alternative paragraph:                      All of the components of integrated carbon dioxide capture and storage (CCS) systems exists and are in use today by the hydrocarbon exploration, production and transport; petrochemical refining; and power engineering sectors. A complete end-to-end CCS system would mitigate CO2 emissions by capturing CO2 from large (e.g., typically larger than 0.1 MtCO2/year) stationary point sources, compressing the captured CO2, transporting and injecting the compressed CO2 into a suitable deep (typically more than 800m below the surface) geologic structures, and then applying a suite of measurement, monitoring and verification technologies to ensure the safety, efficacy, and permanence of the captured CO2's isolation from the atmosphere (IPCC, 2005; HJ Herzog, 2011).</p>	Rejected. Not supported by a compelling body of scientific evidence/publications. The text as currently written in Chapter 7.5.5 is more accurate than this suggested revision.

**Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7**

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
12626	7	30	39	30	39	"would mitigate" should be changed to present tense "mitigates" as it is happening today.	Editorial. That sentence was meant to define CCS. There was no greater point being articulated. The verb tense can be changed but I don't think this is necessary as the existing CCS projects are described in a subsequent paragraph thus making implicitly the point that CCS is already mitigating at some small scale.
12669	7	30	39	30	39	"would mitigate" should be changed to present tense "mitigates" as it is happening today.	Editorial. That sentence was meant to define CCS. There was no greater point being articulated. The verb tense can be changed but I don't think this is necessary as the existing CCS projects are described in a subsequent paragraph thus making implicitly the point that CCS is already mitigating at some small scale.
6426	7	30	40	30	43	somewhere in here it should state the the CO2 is injected as a liquid or a supercritical fluid	Rejected (not supported by the broad body of peer reviewed literature). In the CCS technical literature and for most CCS applications one would use the term "super critical CO2." However, this section 7.5.5. needs to be written in a way that allows a broader and in particular non-CCS specialist reader to understand the text. The text currently reads "injecting the compressed CO2 into a suitable deep geologic formation." For CO2 storage into a deep unmiable coal seam the CO2 would be "compressed" but would not be in a supercritical state. So the use of the more vague phrasing "injecting the compressed CO2" was intentional.
10534	7	30				Missing something on super-conductors	Rejected outside the scope of this chapter not supported by peer reviewed research Super conductors are not a part of CCS systems. Perhaps this is a comment for some other section of Chapter 7.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13491	7	30	1	30	2	Text: "Approximately 25% of all losses in Europe are due to distribution transformers (and this will be similar in OECD countries) so use of improved transformer designs can make a significant impact." A programme of replacement of equipment in the electricity grids is a major undertaking, and cannot be expected without mandatory efficiency targets being set for utility companies.	Accepted - I have added a phrase.
3452	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	Rejected - as there is no clear pattern here - Chile even with its highly extensive transmission manages much lower losses than those quoted here.
3396	7	30		32		There is an IPCC SR on CCS 2005 and additional input in a two page summary requires careful choice of new messages. As in previous sections, avoid mixing reference to individual authors to support well established ideas in the IPCC SR. For example, references in lines 9-13 of page 7 can be omitted. Lines 13-17 must be deleted as they refer to a single (out of many more) research lines with a high level of inmaturity and speculative character (chemical looping concepts for O2 and CO2 are regarded by most experts as priority R&D options for advnaced CO2 capture systems and have reached a relevant pilot scale-up, while ionic liquids have not yet passed the basic conceptual-laboratory scale-test, membranes are not even mentioned (and they should not)... ). Amuzing number of referenes to support simple ideas between lines 18-44 in page 31. If we got to this level of referencing detail in the rest of the Chapter we would escalete to hundreds of pages of referenes;jj. Page 32 line 13 starts with a poor and obscure sentence: "...one of the most sophisitcated analyses done to date": is it good to be "sophisticated"?. The last paragraph of the section (page 32 line 15 to 28) is better discussed in section 7.12.	Accepted. The number of references in section 7.5.5 has been cut down.
9650	7	30				No mention of biosequestration or mineral carbonation	Rejected. Beyond the scope of this chapter. Mineralization is discussed at length in the IPCC SR on CCS. This was a decision the CLA's made when the very first CCS section was written. The decision was to stick to core aspects of CCS and not try to provide a laundry list of all possible topics. I do not know what "bio sequestration" means in terms of CCS.
6436	7	30				Since AR4 the theoretical and practical aspects of CCS have been examined and the paucity of real-world data highlighted (Page et. al., 2009). It has been shown that most energy penalty values are the product of mathematical models and that limited energy penalty data from pilot-scale studies are higher than the modelled values. I suggest that the present status of energy penalty data on CCS applied to electricity generation is reviewed and reported in AR5. In addition the likelihood that CCS electricity plants will be used as baseload plants will limit the penetration of variable renewables (references given in the comments on the next section. Additional reference on CCS: 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. Outside the scope of this chapter given space constraints. I don't see any reason to add a citation to this paper by the commenter. This small section of Chapter 7 can not cover every possible point about CCS. And it is my judgment that this is not a particularly important point for the purposes of an IPCC assessment.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2830	7	30	36	32	28	This section seems out of touch and out of date. It talks about “dozens” of demonstrations worldwide without pointing to the recent cancellation of many of them. It would not be apparent to a reader of this section why a recent journal article was entitled “How a ‘Low Carbon’ innovation can fail – tales from a ‘Lost Decade’ for carbon capture, transport and sequestration” (Economics of Energy and Environmental Policy vol 1 issue 2). The authors may not agree with this assessment but they should recognise the challenges it describes.	Rejected-- not consistent with the underlying peer reviewed literature. As clearly stated in the paragraph in question, CCS will not deploy unless there is a significant climate policy in place. CCS has only one purpose to reduce CO2 emissions to the atmosphere. The lack of commercial CCS deployment is an issue caused by humanity's lack of progress in developing and enacting climate policy. It is not a proxy for a technological shortcoming in the underlying technologies that make up a complete CCS system.
10959	7	30	36	32	28	Confer: Torvanger, Grimstad, Lindeberg, Rive, Rypdal, Bieltvedt Skeie, Fuglestvedt, Tollefsen (2012), Quality of geological CO2 storage to avoid jeopardizing climate targets, Climatic Change, 114, 245-260. Confer also: Torvanger, Lund, Rive, Carbon capture and storage deployment rates: needs and feasibility, Mitigation and Adaptation Strategies for Global Change, DOI: <a href="http://dx.doi.org/10.1007/s11027-012-9357-7">http://dx.doi.org/10.1007/s11027-012-9357-7</a>	Noted. These two papers cover the same material that is discussed in other works already cited in Chapter 7.5.5. Given the limited amount of space available in Chapter 7.5.5 there isn't room to cite these papers as the points made in them are already well documented in the literature cited in Chapter 7.
4214	7	30	36	32	28	While CCS technologies are presented as being well established, the section does not address the substantial barriers to their timely and economical implementation. Standards and regulations must be developed, adopted and implemented with full participation and concurrence of all stakeholders, public and private. The needed national and international standards do not yet exist; their development, with strong public and private sector involvement, will require years of effort. This should be recognized in the report. Given the standards and regulations, individual projects still need to be approved by cognizant local, state and national regulators - a process that can take a decade unless the processes of the many regulators are coordinated and are supported by modern information technologies (Moving Forward: In-Depth Findings and Recommendations from the Consultative Council (2011), National Institute of Building Sciences, p11 ( <a href="http://nibs.org/client/assets/files/nibs/2011_MovingForward.pdf">http://nibs.org/client/assets/files/nibs/2011_MovingForward.pdf</a> )).	Taken into account. These points are addressed in Section 7. These points are made in the later sections of Chapter 7.9.2, 7.9.3., 7.9.4, 7.10. Many commenters seem to want one coherent discussion of CCS and nuclear power. The original submissions for both of these topics were more of an integrated assessment. But much of this text has been dispersed to different sections of the chapter. This leads reviewers to say that this point is missing. It is not missing. It is just not in the place where they expect it to be. Assuming the structure of Chapter 7 isn't going to be completely reorganized again, I don't think there is a need for any changes based on this and similar comments.

**Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7**

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
12328	7	30	36			This section gives a better description of CCS than the description in Chapter 10. Please make sure the descriptions are more consistent between the two Chapters, and this section 7.5.3 should be the basis.	Noted. No action required for Chapter 7.
17748	7	31	1			replace "mind" by "mid"	Editorial. Text has been rewritten making this point obsolete.
9266	7	31	1	31	1	Start of second sentence does not make sense "As of Mind ..." - perhaps it is meant to say "As of mid ..."	Editorial. Typo has been corrected.
8907	7	31	1			Typo - "mind" should be "mid"	Editorial. Text has been rewritten making this point obsolete.
13295	7	31	1	31	1	The word 'mind' should presumably be 'mid'	Editorial. Typo has been corrected.
4523	7	31	1	31	4	The GCCSI reference give 8 large scale integrated projects in operation not 4.	Accepted. Text has been rewritten making this point obsolete.
4811	7	31	1	31	1	As of mid 2012, instead of mind 2012.	Editorial. Typo has been corrected.
5156	7	31	1	31	1	last sentence: --mind?	Editorial. Typo has been corrected.
2784	7	31	1	31	5	I think it is worth making the point that none of the four functioning CCS projects are in the power sector. Making CCS work in the power sector is still a major challenge.	Accepted. Text has been rewritten making this point obsolete. The text in Chapter 7 is clear that early CCS deployment will occur outside of the power sector which is certainly what is taking place in the real world
2273	7	31	13	31	17	Given the breadth of potentially promising advanced capture technologies, the specific emphasis on amino acids and iocinic liquid based capture materials appears to be a bit arbitrary.	Accepted. Text has been rewritten making this point obsolete.
5733	7	31	13	31	17	<p>Currently, post-combustion capture from coal-fired power plants using solvent scrubbing must be technologically capable. However, NETL (Figueroa et al., 2008) and Davidson (2009) show the vision of innovative CO2 capture technologies from a perspective of time to commercialization and cost reduction benefit. Advanced technologies such as solid sorbents, membrane systems (Kai et al., 2008), ionic liquids, MOFs and enzymatic membranes, are expected to follow amine scrubbing systems.</p> <p>J. D. Figueroa, T. Fout, S. Plasynski, H. McIlvried, R. D. Srivastava, "Advanced in CO2 capture technology – the U.S. Department of Energy's Carbon Sequestration Program", International Journal of Greenhouse Gas Control, 2(1), 9-20 (2008)</p> <p>R. Davidson, "Post-combustion carbon capture – solid sorbents and membranes", CCC/144, IEA Clean Coal Centre (2009)</p> <p>T. Kai, T. Kouketsu, S. Duan, S. Kazama, K. Yamada, "Development of commercial-sized dendrimer composite membrane modules for CO2 removal from flue gas", Sep. Purif. Tech., 63 (2008) 524-530.</p>	Accepted. Text has been rewritten making this point obsolete.

**Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7**

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
8908	7	31	14			The following statement "Wappel et al., (2010), and Vaidhyanathan (2010) are exploring advanced CO2 capture systems based upon novel approaches using amino acid and iocinc liquidbased capture materials which potentially represent the core of new CO2 capture systems that would require dramatically less energy (typically heat) to regenerate the capture solvent." is unnecessary and implies that ionic liquids and ammino-acid based CCS systems are significantly better than other advanced systems which are currently being researched (sorbent-enhanced shift, chemical looping, carbonate looping, ZECA, etc, etc). There are many others which should be mentioned if these two types of CCS are singled out for special treatment. There are also numerous issues with ionic liquids - high viscosity being probably the most challenging. The statement should be ommitted or simply left as "many advanced CCS technologies are being studied". Further details comparing the pros and cons of different advanced technologies are available in Mac Dowell, N., et al., An Overview of CO2 capture technologies. Energy and Environmental Science, 2010. 3 (11): p. 1645 - 1669.	Accepted / taken into account. The sections on CCS have been substantially rewritten to bring out the pros and the cons of the technology
3001	7	31	14			I could not understand the emphasis given to the research of Vaidhyanathan (2010) on iocinc liquidbased capture materials. The text states that this "potentially represents the core of new CO2 capture systems that would require dramatically less energy (typically heat) to regenerate the capture solvent." Unfortunately, this is a very partial statement that, first, does not recognize the vast and diverse literature related to studies for reducing energy penalty; and, second, poses its expectation on a solely solution, which is very doubtful. I strong recommend to cite other studies that were published, showing that there is not yet a single and winner solution to reduce the energy penalty of post-combustion capture plants. Only to cite few examples, please see: Rochedo, P.R.R., Szklo, A.S., 2012. Work of Separation and Learning Curves for Carbon Capture based on Chemical Absorption. In: 7th Conference on Sustainable Development of Energy, Water and Environment Systems – SDEWES Conference, Ohrid-Macedonia. Raynal, L., Bouillon, P.A., Gomez, A., Broutin, P., From MEA to demixing solvents and future steps, a roadmap for lowering the cost of post-combustion carbon capture. Chem. Eng. J. Vol.171 No.3, pp 742-752, 2011. Zanganeh, K., Shafeen, A., 2007. A novel process integration, optimization and design approach for large-scale implementation of oxyfired coal power plants with CO2 capture. International Journal Of Greenhouse Gas Control 1, 47–54. Rochelle, G., Chen, E., Freeman, S., et al, Aqueous piperazine as the new standard for CO2 capture technology." Chem. Eng. J. Vol. 171 pp. 725-733, 2011. Svendsen, H. F., Hessen, E. T., Mejdell, T., Carbon dioxide capture by absorption, challenges and possibilities. Chem. Eng. J., Vol. 171, No. 3, pp 718-724, 2011.	Accepted. Text in section 7.5.5 has been substantially rewritten making this point obsolete. Hopefully the revised text is not nearly as narrowly focused as the FOD text on this point.
17365	7	31	15			ionic liquid-based capture...	Accepted / taken into account. The sections on CCS have been substantially rewritten to bring out the pros and the cons of the technology
4440	7	31	18	31	18	Quantify the high capital costs, for example as a proportion of new powerplant capital expenditure or final cost of electricity.	Taken into Account. The text in 7.5.5 now clearly says "Estimates for CO2 capture costs are summarized in sections 7.8.2."
15481	7	31	18	31	20	High capital costs as such do NOT drive CCS plants down the dispatch curve - you want to run a plant intensively if its variable costs are low, which is a different matter. The issue is more that you would only want to build something with high capital costs IF it had low variable costs and therefore could be run intensively. See eg Stoft, Power System economics, Wiley 2003, or Kirschen and Strbac, Fundamentals of Power System Economics, Wiley 2004, or Green, OXREP 2001 or 2005 or many other sources!	Accepted. New text is not in this section that hopefully clarifies this point.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2831	7	31	18	31	20	This sentence is odd given that, as the text recognises, there are no large scale commercial CCS power plants so it is not clear what it is supposed to be describing. In a future low carbon system dominated by renewables and nuclear, CCS plant might have to operate flexibly; the problem is how to construct the necessary incentives. Page 38 explains this better.	Rejected. No scientific evidence or peer reviewed publications offered in support of reviewer's comment.
11855	7	31	18	31	23	It is unclear what the term "single purpose" refers to here (and earlier). And why does CCS's 'single purpose' define its likely use only on baseload power systems?	Noted. The single purpose nature of CCS is an important issue as it contextualizes when and why CCS will deploy
6189	7	31	18	31	20	"The high capital costs and single purpose use for CO2 capture equipment when mated to power plants drives these CCS-enabled power plants down the dispatch curve where they serve primarily to produce baseload power." This sentence seems flawed. The high capital costs may serve to discourage CCS-enabled plants from being built to serve new capacity, but once built those capital costs should not affect its merit order in dispatching.	Accepted. New text is not in this section that hopefully clarifies this point.
11856	7	31	26		27	The following wording "are likely to arise in the aspects of the industrial sector that produce high purity 27 CO2 waste streams that are typically vented to the atmosphere" is confusing. What is meant by 'aspects' in this context? Also, is it possible to give a few examples of the industries that produce these high-purity CO2 waste streams?	Noted. The single purpose nature of CCS is an important issue as it contextualizes when and why CCS will be deployed.
6697	7	31	28	31	33	The cost of CCS project depends on conditions, for example its location, fuel used. Recent studies show that various problems with the large-scale realization of carbon CCS have been indicated; most important among them is its cost. "at about \$100/tonCO2 the electricity sector is largely decarbonized with a significant fraction being from CCS deployment" isn't necessarily true.  See: Finkenrath, M. (2011) Cost and Performance of Carbon Dioxide Capture from Power Generation, International Energy Agency. The same study was published as the following peer-reviewed article (but was only available for 24-hour access online): Finkenrath, M. (2012) Carbon Dioxide Capture from Power Generation – Status of Cost and Performance. Chem. Eng. Technol., 35: 482–488.	Rejected. Not supported by accessible peer reviewed literature. Since this is not accessible I don't see that it can or should be cited. Also it is not clear if the two reports being referenced here are reporting first of a kind costs or n-th of a kind costs. Suggest no changes to the text in Chapter 7 as currently written. This text has now been moved to section 7.11.3
9471	7	31	28	31	33	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. I am not sure what the meaning of "facts" is here in the commenters note. The sentence that is being referenced is an accurate description of the underlying literature.
9263	7	31	28	31	28	The figure of 100\$/ton is old and depends on many factors. Figures around \$60/t are now likely to be achieved with existing technology, though that's in optimal conditions. Maybe specify a range or state "up to \$100/t"? Needs reviewing/update check.	Noted. Whether it is \$60 or \$100/tonCO2 doesn't really matter in terms of the point being made here which is that CCS sets a backstop price for the electricity sector. This text has now been moved to section 7.11.3
2832	7	31	28	31	33	This is another case where evidence from models should be qualified by reference to empirical evidence – see article referenced above. Even if models agree they do not necessarily provide much of a guide to the real world it is symptomatic that a modelling result is described as an "important insight".	Noted. No change required.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16814	7	31	28		33	Suggest adding something to make clear the following: Economic modeling demonstrates the importance of CCS technology in terms of driving the costs of meeting stringent CO2 caps. If CCS is expensive, the CO2 price will be higher. If CCS is relatively inexpensive, the CO2 price will be lower. CCS, as a means to lower CO2 emissions, is much less costly than many other large scale mitigation options.	Noted. The text in question has now been moved to section 7.11.3 where it is presented in a broader context that hopefully brings forward the nuance the commenter wanted to see
4812	7	31	28	31	28	Add price to the line: at a PRICE of about \$100/tonCO2	Noted.
9490	7	31	28			Rewrite or delete reference to '\$100/tCO2' in the context of CCS. This gives the wrong impression as CCS will in most cases be cheaper, and 70% cheaper than CO2 abatement without CCS (ref IEA Blue Map Scenario.	Reject. Not supported by the peer reviewed literature. I do not agree (to the extent I understand the review comment) and I do not believe this will improve the readability of the text. The specific text in question has been moved to section 7.11.3
9993	7	31	28	31	33	This part should explain that there are many concerns about CCS. Even if carbon price maintain more than \$100/tCO2, it is difficult to apply CCS in the real world because of technological, geographical, and public acceptance issues etc., as described in (Finkenrath, 2011, page39) and (Zobacka, 2012, Abstract). These literatures are listed in the No47 line of this table.	Taken into Account. The sections on CCS have been substantially rewritten to bring out the pros and the cons of the technology. NB. The discussion of CCS is spread across many parts of Chapter 7
4441	7	31	30	31	33	Net CO2 removal from the atmosphere when including land use changes and other externalities?	Noted. Yes, this is what the literature being summarized here is saying.
16114	7	31	34	31	42	The body of evidence does not go one way, as the message in this paragraph tends to say. What about earthquakes menacing the integrity of reservoirs? (e.g. Zoback M., Gorelick 2012 "Earthquake triggering and large-scale geologic storage of carbon dioxide" PNAS 109:5185–5189). This particular paper came after 2011, but so do several informations given in the same section (e.g. p.31 line 7, line 21, line 39...)	Taken into Account. The sections on CCS have been substantially rewritten to bring out the pros and the cons of the technology. NB. The discussion of CCS is spread across many parts of Chapter 7
7732	7	31	39	31	42	It is still premature to consider risk-reduction for CCS.	Rejected. Not supported by the peer reviewed literature. Furthermore, I don't know what the basis is for saying it is premature to think about risk. It seems that before deploying CCS is exactly the right time to think about risk mitigation.
2274	7	31	42	31	42	While a reference to a discussion of storage risks in chapter 7.9.3 is provided, they are nowhere mentioned in 7.9.3.	Taken into Account. The sections on CCS have been substantially rewritten. The risks of CCS and the means to mitigate them are now dealt with in Section 7.5.5 as this material fits better here than in section 7.9

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16039	7	31	42			In 7.9.3 is no discussion of storage risks.	Accepted / taken into Account. The sections on CCS have been substantially rewritten. The risks of CCS and the means to mitigate them are now dealt with in Section 7.5.5 as this material fits better here than in section 7.9
16115	7	31	43	32	28	The methodology for CCS is more balanced in its description of progress than previous paragraphs, but it does not describe the confidence level of the assessments quoted. This weakens the argument and looks like a plaidoyer in favour of CCS. In particular, the final sentence "the relative cost (...) could still be competitive with other large scale emissions mitigation measures" looks like a lobbying pamphlet and is ironic when no economic project has been started anywhere.	Rejected. No scientific evidence or peer reviewed publications offered in support of reviewer's comment. There is plenty of literature that comports with the idea of CCS being cost competitive with other large scale emissions mitigation activities.
2275	7	31	43	32	28	These two sections on CO2 storage do seem to "downplay" a bit the existing differences in CO2 storage capacity evaluation methodologies used across the world (some of which have quite significant differences in e.g. storage efficiency factor assessment or if they include open structures as well in their estimates) and the underlying uncertainty of CO2 storage capacity estimates across most regions in the world (apart from a few highly developed countries), given the significant lack of site-specific geological data and injection experience for most regions. (see e.g. Lynton K Spencer, John Bradshaw, Barry E Bradshaw, Anna-Liisa Lahtinen, Alfredo Chirinos: Regional storage capacity estimates: Prospectivity not statistics Energy Procedia, Volume 4, 2011, Pages 4857-4864, or for a summary (in the grey literature) <a href="http://www.iea.org/media/workshops/2012/cert/Causebrook.pdf">http://www.iea.org/media/workshops/2012/cert/Causebrook.pdf</a> )	Rejected. Beyond the scope of Chapter 7. Yes there are differences in CO2 storage capacity methodologies. However, they are all based upon a fairly uniform set of bulk properties. Discussing these differences is too fine a level of detail for this Chapter.
6427	7	31	46	31	46	remove "just"	Editorial. Text has been rewritten making this point obsolete.
16112	7	31	5	31	6	The expression "critical advances" is clearly too optimistic when so much cost cutting is in order to match the present needs of carbon markets	Rejected -- not supported by the broad body of peer reviewed literature. A vast body of knowledge has been produced by these field experiments. There is no need to denigrate the importance of the knowledge created by these field experiments.
5137	7	31	7		8	Considering the recent decision by the TransAlta ( a Canadian public electricity company) to withdraw from the heavily government subsidized CCS implementation in one of their coal-fired plants, there is some merit to add some discussion to the statement " CCS has not been applied to a large....".	Rejected. Not supported by peer reviewed literature. Not sure what the commenter wants to see done with the text. The cancellation of this particular project is yet more data to support the statement made at the start of this short CCS section that CCS is a single purpose climate mitigation technology that isn't going to deploy unless there are binding requirements to significantly reduce CO2 vented to the atmosphere.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4439	7	31	7	31	8	A sentence could be inserted to describe the barriers to large-scale deployment of CCS solutions. This is relevant both as you have stated that each part of the CCS system exists already in practice and the potential that for CCS to mitigate global warming as discussed on p32, lines 13-28.	Taken into Account. These points are addressed in other parts of Chapter 7. These points are made in the later sections of Chapter 7.9.2, 7.9.3., 7.9.4, 7.10. There is material in Chapter 7 that deals with this set of issues. It is just dispersed and not easy to find.
10535	7	31	7	31	8	How does a 2011 reference quite 2012 information? Also needs a comment on loss of power output due to power demand of CCS system. Also in section 7.5.3 needs a comment on legal liabilities and progress being made in that regard.	Accepted. Section 7.5.5 now explicitly discusses liability and what field research is telling us that informs discussions of liability.
3453	7	31	1	31	8	Are there any cost to present regarding CCS?	Taken into Account. The text in 7.5.5 now clearly says "Estimates for CO2 capture costs are summarized in sections 7.8.2."
13492	7	31	28	31	29	Text: "Integrated assessment models (see Chapter 6) tend to agree that at about \$100/tonCO2 the electricity sector is largely decarbonized with a significant fraction being from CCS deployment" The problem with pricing carbon dioxide emissions is that, since the global economy is highly dependent on carbon dioxide emissions, a level of pricing at \$100/tonCO2 would create significant risk of inflation, which would be followed by economic re-equilibration, after which the carbon price would have no further impact. Plus, in a general atmosphere of volatility in energy prices, it is unlikely that a carbon emissions price of any amount would create enough of a signal to trigger decarbonisation - neither in energy efficiency, energy conservation, energy plant replacement, or in new energy sector investment. In fact, a strong carbon emissions price could deter energy users from investing in new energy resources, as they would be under financial duress from the carbon emissions pricing. There are too many forces and factors that would conspire to keep the price of carbon dioxide emissions "cost-efficient" and marginal, so it is hard to imagine a high price for carbon dioxide under any regime proposed to date.	Noted. The text as currently written accurately reflects the peer reviewed literature. It is clear that this reviewer does not agree with whether this is "likely" but that doesn't make what is written here wrong or doesn't require any changes.
10049	7	31	28	31	30	Integrated assessment models do not reflect the technical possibility of large scale CCS and do not take into account the real costs of CCS equipment in the current development stage, nor the significant efficiency losses of power plants using CCS technology. It is important to note, that these intergrated simply assume that technology might work and that this technology might be available. In all energy modell, CCS grows on the expense of (lower cost) renewable energy. The current paragraph is misleading and must be significantly rewritten to reflect the assumptions used in those modell in order to come to the quoted results.	Rejected. No scientific evidence or body of peer reviewed literature is offered in support of the comment. Chapter 6 deals with the capabilities and limits of integrated assessment models. There is no space to repeat that discussion in Chapter 7 and there certainly is no room to cover that same ground as it relates to one sentence about CCS deployment. This text has now been moved to section 7.11.3
11932	7	32	1			CO2 storage "potential" (or capacity)?	Note -- storage capacity is meant which becomes clear from the context and the beginning of the paragraph which speaks about "storage capacity methodologies".

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
15488	7	32	17	32	24	Quote at least fossil energies subsidies schemes which are part of difficulties RES face to reflect the real price	Rejected - comment seems to be misplaced - please clarify to which part of the chapter the comment refers to.
15489	7	32	17	32	24	Introduce in a short sentence positive externalities and the concept of energy service	Rejected - comment seems to be misplaced - please clarify to which part of the chapter the comment refers to.
9488	7	32	2			reference to storage capacity in utsira fm - should refer to NPD(2012). Reference toSTRACHAN ET AL not relevant .- refer to <a href="http://www.npd.no/en/publications/reports/co2-storage-atlas/">http://www.npd.no/en/publications/reports/co2-storage-atlas/</a>	Accepted. Reference changed.
6698	7	32	26	32	28	The cost of CCS depends on the distance from emission source to storage site, geological and geographical conditions. It should be noticed that the places where CCS plants can be economically installed are limited. Recent studies show that adding carbon capture and storage to a reference-case supercritical pulverized coal (PC) unit would raise the cost of electricity from 5.3¢/kWh to 8.8¢/kWh, and that the cost of CO2 avoided would be \$49.7 per tonne. Thus CCS is not estimated to be cost competitive at this time.  See: Rubin, E.S., C. Chen & A.B. Rao (2007) Cost and performance of fossil fuel power plants with CO2 capture and storage. Energy Policy 35, 4444–4454.	Taken into account. These points are covered extensively in the Chapter.
9994	7	32	26	32	28	This part should explain that there are only limited places where CCS is economical. Cost for CCS is related to geological and geographical conditions of the site such as the distance between CO2 emission source and storage site, as described in (Finkenrath, 2011, page39). This literature is listed in the No47 line of this table.	Taken into account. These points are covered 7.8.2.1
18054	7	32	30	35	30	It could be worth adding that this "small fraction" already covers 20% of the world's electricity needs.	Accepted - we have noted the contribution of RE to electricity to provide context also to the growth we have seem
4813	7	32	30	32	30	Provide figures for potential RE and the fraction currently used, if available	Accepted - We have links to the earlier section where technical potentials are addressed. Due to space limitations we have not quantitatively compared the technical potential to actual use, but have instead linked to the SRREN, which does address this issue
2585	7	32	43	33	2	Hydropower: Technological progress increased the energy conversion to 90%; so nowadays, it is economically viable to install and exploit microhydropower.	Rejected - this improvement has not really been dramatic since the AR4, and here we are only providing a couple examples. We do not have space to provide the large number of other examples that could be added.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10536	7	32	43	32	47	Not clear why only these 3 examples are "notable". Could add geothermal (eg EGS or binary) and hydro (eg low head) to give better balance.	Accepted - we do not use the word "notable" alone, but instead make it clear that these are merely examples. We did not, however, add a lot of additional examples (other than CSP) as we are severely space constrained, and the examples could easily see no end. We have chosen a range of examples that, to us, provide a good balance of recent advancements. We have cited the SRREN to direct the reader to more details, and further examples.
12599	7	32	44			I think the major reason for the reduction in the price of PV has been the subsidization of Chinese PV factories by the Chinese government	Rejected - there is no peer reviewed literature that we are aware of, or even grey literature, that suggests this to be the case. The production cost of solar modules is now below \$1/W, whereas modules sold for \$4/W only 5 years ago. While there may well be some effect from subsidies from China, as suggested in the US trade case, that represents only a small part of the cost decline. We have however, noted that market conditions have also helped drop the price of PV, as supply well exceeds demand.
12598	7	32	46			The reason we look to creating larger offshore wind turbines is that this means there is less infrastructure, as less turbines for the same energy output	Accepted - we have noted improvements in the cost structure of wind as a result, though we do not have the space to really provide the details
18056	7	32	46	32	46	write: "continued increase in the size, efficiency and therefore energy capture (...)"	Rejected - efficiency is not a well defined term in the wind industry, in our view. In fact, the trend towards larger rotors (with similar generator size) leads to greater energy capture, but efficiency is arguably reduced in that a smaller fraction of the available wind to the rotor is actually converted to electricity. Absent a clear definition of efficiency, we choose not to insert that word here.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18055	7	32	46	32	47	Add: "increasing their yield and, thereby, economic viability." as the cost effect is made explicit for the other technologies in the paragraph - not for wind energy.	Accepted - we have noted the cost effect, though not in exactly the way suggested
12108	7	32	19	33	20	In the discussion of technical potential for renewable energy - whilst it is important, as you have done, to be sober in this assessment, the fact that there is a large body of literature showing the technical potential for a transition to 80-100% renewable energy for electricity generation for many countries, now is surely important to note.....For an overview of this literature please see - Elliston B, Diesendorf M, MacGill I, 2012, 'Simulations of Scenarios with 100% Renewable Electricity in the Australian National Electricity Market'. Energy Policy 45:606-613. <a href="http://www.ies.unsw.edu.au/docs/diesendorf-simulations.pdf">http://www.ies.unsw.edu.au/docs/diesendorf-simulations.pdf</a>	Rejected - the issue is interesting but space constraints do not allow for an extended discussion. Please provide peer-reviewed literature to support your arguments.
12109	7	32	19	33	20	In the discussion of the technical potential of renewable energy - there is no discussion of the fact that a significant barrier to achieving 80-100 percent is the myth that "renewable energy cannot provide baseload power." It is obvious that four types of renewable sources – hydro, biomass, hot rock geothermal and solar thermal - can provide baseload power. Graham Sinden at Oxford University has also found that wind, wave, solar and tidal power can also provide base load electricity when used in combination on a large scale separated by several hundred kilometres and subject to different wind, wave, solar or tidal regimes. The total output of such systems generally varies smoothly. Based on historical data, he found that it would be impossible for such an integrated system to be in a situation of no wind, waves, sun or tidal change at any site. He has also demonstrated that most of the UK's electricity could be generated from renewable. [REF -Sinden. G. (2006) Diversified renewable energy resources. Carbon Trust. <a href="http://www.eci.ox.ac.uk/people/sindengraham.php">http://www.eci.ox.ac.uk/people/sindengraham.php</a> ] Other research groups have come to similar conclusions for other countries. - Sigurd Weinreich's team at The Centre for European Economic Research, has developed a model that shows it is technologically and economically affordable for the EU to make a transition over the coming decades to meeting 100 percent of their electricity needs from renewable and distributed energy sources. [Weinreich, S. et al (1998) 'Long-Term Integration of Renewable Energy Sources into the European Energy System', Environmental and Resource Economics, LTIResearch Group, Physica Verlag, Heidelberg. Available at <a href="http://www.amazon.com/Long-Term-Integration-Renewable-Environmental-Economics/dp/3790811041">http://www.amazon.com/Long-Term-Integration-Renewable-Environmental-Economics/dp/3790811041</a> . ] - Further literature overviewed in Elliston B, Diesendorf M, MacGill I, 2012, 'Simulations of Scenarios with 100% Renewable Electricity in the Australian National Electricity Market'. Energy Policy 45:606-613. <a href="http://www.ies.unsw.edu.au/docs/diesendorf-simulations.pdf">http://www.ies.unsw.edu.au/docs/diesendorf-simulations.pdf</a>	Rejected - the myth might be part of the political debate. The AR5 is a scientific assessment report, which summarizes the peer-reviewed literature. It does not have the obligation to observe the political debate and to correct potential misunderstandings. A balanced discussion of the challenges associated with providing high shares of RE is given in chapter 7.4.2 and 7.6..1.
12107	7	32	29	33	20	Shouldn't co-generation and tri-generation - combined heat and power be mentioned either in the renewable energy section or at least somewhere else appropriate in this chapter? I could find no mention of co-generation or tri-generation in the "Energy Systems" chapter 7.	Accepted - it is mentioned in 7.5.1 already; comment best addressed to that section

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4109	7	32	29	34	14	Section 7.4.3 was weak, but Section 7.5.4 Renewable Energy is even weaker. Issues such as power densities, real potential, and the plethora of exaggerated claims about performance to date and prospects are not dealt with. Is this all that can be said about CSP (page 33, line 10), or biofuels (page 34, lines 10-11) - already a disaster zone in the US transportation sector. Grand statements about the increased energy capture of wind turbines overlooks the pattern of placing Vestas V90 machines where mean wind speeds are low, to increase energy capture and apparent capacity factor achievement while having too small a turbine etc to operate optimally in terms of total capex (the so-called Pickenham effect). Etc, etc. A complete rewrite is recommended.	Rejected - This section derives much of its material from the core material in the IPCC SRREN report, which we feel is appropriate. Technical potential is addressed in an earlier section. "Real" potential is not a well defined term, but is addressed to some degree in the scenarios section 7.11, which addresses deployment in various carbon mitigation scenarios. Economics is addressed in a later section of the chapter as well. These various issues were not intended to be covered in this specific subsection, and comments on those topics should therefore be directed to other sections by and large. We do not have the space to allow discussion of individual technologies in much depth. CSP, however, is addressed to some extent in the "infrastructure/integration" sections, as its primary advantage is that of thermal storage, issues addressed in the later section. Biofuels issues, including the many concerns, are similarly addressed elsewhere in the chapter, and in other chapters of AR5. The statement about increased energy capture of wind is technically accurate and, in our view, not particularly "grand" - it is, however, having a sizable impact on where projects can be realistically located while still meeting minimum economic criteria. Issues of diffuse energy flows, variability, location dependence are all mentioned in this section, but not in depth, as we point the reader to other sections of the chapter where those issues are addressed. As such, comment is better addressed in other
11933	7	32	29			Section could be reduced somewhat and simply refer to the recent IPCC report on RE, with one-line conclusions and references given here.	Noted -text reduced somewhat in places, but also augmented in others, with extensive referencing to the SRREN. Text is within its internal page limit.
10960	7	32	29	34	14	Confer: Torvanger, Lund, Rive, Carbon capture and storage deployment rates: needs and feasibility, Mitigation and Adaptation Strategies for Global Change, DOI: <a href="http://dx.doi.org/10.1007/s11027-012-9357-7">http://dx.doi.org/10.1007/s11027-012-9357-7</a>	Taken into account. See comment above (4109) that suggested the inclusion of this paper in another part of Chapter 7.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
15487	7	32	31	32	32	Rewrite the sentence in brackets in a positive formulation “most, but not all, forms of RE supply have low life-cycle GHG emissions in comparison to fossil fuels » to avoid any misunderstand (even if the affirmation is true but comparing RE footprint in general as fossil fuels in general make no sense)	Rejected - We are not certain what the comment wants us to do with the sentence. Without further clarification on the comment, we will keep the sentence as it stands.
7124	7	32	34	34	13	These paragraphs may be deleted. The content in these paragraphs does not seem to focus on the section 7.5 title "Mitigation technology options, practices and behavioural aspects". However, some of the text could be moved to section 7.4.3 to serve as background material on Renewable Energy resources.	Rejected - the text here relates to conversion technologies, not resources.
3260	7	32			33	1. This chapter needs more structure, by trying maybe a table or iconic figure that recapitulate all sources of energy described (nuclear, fossil, gas, hydrological, bioenergy, hydropower, windpower, solar energy, geothermal etc) and map for each the acceptability and behavioural implications. 2. Another suggestion on the change in the energy sector is the modification of land use for some of these sectors ( hydropower means big dams and a big change in water cycle, water flow, freshwater ecosystems, and other human impacts that can result in GHG emission).	Rejected - The acceptability issues are addressed elsewhere in the chapter, not in this subsection. Same is true on land use - those issues are addressed later in the chapter. Comment is really an overarching one that applies to the full chapter, so while it may be appropriate, it does not require changes in 7.5.4 per se.
13201	7	33	10	33	10	The first time CSP is used, explicit the meaning Concentrated Solar Power	Accepted
12600	7	33	13			Tidal devices have not really settled on one general commercial design, but they generally are horizontal axis turbines, for example Evopod, Open Hydro, Tidel and Marine Current Turbines. The only other main contender for this approach is the hydrofoil based devices such as Pulse Tidel. Wave is much more under development, generally devices are point absorbers, hydraulic or overtopping,	Accepted - we cannot provide these details, but we have added "certain types of tidal barrages" to make it clear that not all today devices are technically mature.
12601	7	33	14			Typical three bladed horizontal axis turbine is mature, but there is still much work on a range of vertical axis turbines. Mostly these are for the urban environment where turbulent winds are supposed to, anecdotally, mean the vertical axis systems work better than horizontal. However, there is also the Aerogenerator X, a vertical offshore system hoped to scale up to 10MW – see <a href="http://www.windpower.ltd.uk/">http://www.windpower.ltd.uk/</a>	Accepted - we have added "traditional" to note that traditional land based technology is mature. We do not have the space to discuss more radical design changes to onshore technology.
18057	7	33	15	33	15	Delete "relatively".	Accepted
17367	7	33	15	33	16	is increasing but is commercially mature...	Rejected - we believe that offshore wind is less technically and commercially mature. That said, the word commercial maturity is poorly defined. We eliminated it and instead noted that offshore wind is less technically mature and is typically more costly than traditional onshore wind. We think this statement is more clear and accurate.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18209	7	33	17		24	Delete: Because the cost of many RE technologies has historically been higher than market energy prices (e.g. Fishedick et al., 2011; Section 7.8), public R&D programs have been important and government policies have played a major role in defining the amount and location of RE deployment (Mitchell et al., 2011; IEA, 2011e; REN21, 2012). Additionally, because RE relies on natural energy flows, RE technologies must often be located at or near the energy resource, often collect energy from diffuse energy flows, and may produce energy output that is variable and—to some degree—unpredictable (IPCC, 2011b). The implications of these characteristics for infrastructure development and network integration are addressed in Section 7.6. Comments: Should be complemented by that R & D by the public sector institutions and associated patents most industrialized countries, could play an important role with respect to the effective transfer of technology to developing countries. it being understood that technology transfer is presumed easier when it comes to patents public sector private sector.	Rejected - We are not sure what is being requested, but we believe that the existing text is important to maintain. Issues of technology transfer are very important, but are not in the domain of this subsection - they are addressed elsewhere in the AR5 chapters.
18210	7	33	17		24	Alternative paragraph: Because the cost of many RE technologies has historically been higher than market energy prices (e.g. Fishedick et al., 2011; Section 7.8). Additionally, because RE relies on natural energy flows, RE technologies must often be located at or near the energy resource, often collect energy from diffuse energy flows, and may produce energy output that is variable and to some degree unpredictable (IPCC, 2011b). The implications of these characteristics for infrastructure development and network integration are addressed in Section 7.6.	Rejected - It seems that the commenter wishes to eliminate the text on the importance of R&D in driving costs lower, and the impact of policy in driving development. We think that these points are very important to maintain here to provide the proper context for why RE has been growing.
18213	7	33	17		24	Comment: Variable retail prices can be used to make demand responsive to the availability of supply (Borenstein, 2005; Centolella, 2010). Comment: While this is true, people must be educated as to formally rational and efficient use of energy (UREE), in terms of development and sustainable consumption. Alternative paragraph: Variable retail prices can be used to make demand responsive to the availability of supply (Borenstein, 2005; Centolella, 2010).	Rejected - this comment is best addressed in the infrastructure/integration sections where these issues, including demand response, are addressed
2587	7	33	17	33	24	Bioenergy and hydropower can be stocked (thermal solar as well) and together with the integration of solar and wind energy, we can secure the supply.	Accepted - these issues are addressed in a later section of the chapter in more detail, but we made it more clear that the statements made here apply only to a subset of the RE technologies.
4649	7	33	17	33	17	"Because the cost of many RE technologies has historically been higher than market energy prices ---". This does not apply to existing biomass energy use including ethanol from sugar cane. Fuelwood and charcoal are very competitive with the fossil fuel alternatives. It is usually fossil fuels (and electricity) that are subsidized.	Accepted - this is why we use the term "many" but we have also added "not all". We have not added examples here, however, as that is better addressed in the cost section of the chapter.
16041	7	33	17			Because the investment costs of many ... (because the operating costs of RE normally much lower than from other energy systems due not need to by energy feedstock)	Rejected - the point here is simply that the total cost of many RE techs has been higher than market energy prices, which is what dictates the need to policy support to this point

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
12842	7	33	17	33	24	Please include in the discussion whether or not taxes are included when comparing prices of RE and conventional energy. Comparison should be done on a equal base.	Rejected - this statement is based on the IPCC SRREN (and supported by section 7.8), and the reader is directed to that source document for the considerable documentation and caveats that are needed. We do not have the space to include all of the details here.
18059	7	33	22	33	23	Delete "to some degree unpredictable". Wind is variable but highly predictable within the timeframes relevant for efficient system operation. It is unpredictable beyond 1-2 weeks which is irrelevant for systems operation and so are other technologies due to, e.g. unscheduled shut-downs	Rejected - we discuss wind forecasting in a later section of the report. However, we are not aware of peer reviewed literature that suggests that wind forecasting is, in broad terms, better than fossil plant output forecasts. In fact, the many integration studies that have been conducted demonstrate that the level of unpredictability, on a day ahead and hour ahead basis, and even after forecasting, does have implications for unit commitment and dispatch and reserves. These are details are better left for a later section. That said, we have made some small revisions to the text here to note the RE sources can be forecasted, so as not to suggest that output is not able to be forecasted at some level of accuracy. Further details are provided in a later section of the chapter.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16116	7	33	23			The word "unpredictable" should not be used here. In developed areas with experience with windpower, the production of energy is variable but known in advance with very high levels of confidence (less than 10% deviation in 24 hours). This is better than many thermal plants.	Rejected - we discuss wind forecasting in a later section of the report. However, we are not aware of peer reviewed literature that suggests that wind forecasting is, in broad terms, better than fossil plant output forecasts. That said, we have made some small revisions to the text here to note the RE sources can be forecasted, so as not to suggest that output is not able to be forecasted at some level of accuracy. Further details are provided in a later section of the chapter.
11765	7	33	25	33	33	In response to the result of No.50, these sentences should be amended appropriately.	Rejected - sorry, but we do not know what No 50 refers to here.
13296	7	33	25	33	33	As per earlier comment - presumably RE was nearly half of new nameplate (i.e. peak) GW installed; however on average RE technologies will tend to operate at a much lower load factor (e.g. <20% for PV, around 30% for onshore wind) than fossil capacity operating at baseload, so TWh generation from RE installed in 2011 likely to be still considerably lower than that from new fossil plant - RE share might be 20-25%. Given that this is arguably a more accurate reflection of the share of new capacity, it would be worth adding this (probably in addition to the GW share, not instead)	Accepted - we cannot in fact show the incremental contribution to energy supply for the most recent year, as global energy supply statistics are always lagging by ~2 years. So the most recent-year statistics on energy supply contribution growth are not available on a global basis. We certainly agree that those statistics would be valuable (and more useful than capacity growth), however, so we now note the situation in a footnote so that the reader at least understands the limits to capacity growth statistics such as those noted here. We have also made it clear that the RE contribution to electricity supply is ~20%, to provide needed context.
18060	7	33	25	33	27	If we insist referring to renewables as "relatively small", the bracket should say "(excluding traditional biomass and large hydro). The correct would be to write that - due to them coming into the market at a later stage, their share of total current energy supply is small, but their share of the market for new supply is significant globally and dominant regionally.	Accepted - we have presented data here so as not to only use words like "relatively small" that are hard to interpret.

**Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7**

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16816	7	33	25		33	Nameplate capacity of new plant is less meaningful than providing the amount of energy produced (GWhs) as percent of total -- it is important for people to see the progress is being made but that this is still at a relatively small scale.	Accepted - we cannot in fact show the incremental contribution to energy supply for the most recent year, as global energy supply statistics are always lagging by ~2 years. So the most recent-year statistics on energy supply contribution growth are not available on a global basis. We certainly agree that those statistics would be valuable (and more useful than capacity growth), however, so we now note the situation in a footnote so that the reader at least understands the limits to capacity growth statistics such as those noted here. We have also made it clear that the RE contribution to electricity supply in ~20%, to provide needed context.
10538	7	33	25	33	33	This para better merged into section 7.2	Taken into account - for the moment it will stay in this location, but it may be merged later.
5927	7	33	25		33	Presenting only capacities gives a biased picture of the development: annual full-load hours of solar pv are often about 1000 h, wind 2000-2500 h, whereas for conventional generation at about 5000-6000 h in baseload operation and up to 8000 h for nuclear.	Accepted - we cannot in fact show the incremental contribution to energy supply for the most recent year, as global energy supply statistics are always lagging by ~2 years. So the most recent-year statistics on energy supply contribution growth are not available on a global basis. We certainly agree that those statistics would be valuable (and more useful than capacity growth), however, so we now note the situation in a footnote so that the reader at least understands the limits to capacity growth statistics such as those noted here. We have also made it clear that the RE contribution to electricity supply in ~20%, to provide needed context.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9472	7	33	27	33	33	It is written that “RE accounted for almost half of the 208 GW of new electricity generating capacity added globally in 2011”, but mentioning only generation capacity can lead to overevaluation of renewable energy, as many types of renewable energy have low generating efficiency. Taking into account the generating efficiency, electricity generated from renewable energy should be added.	Accepted - we cannot in fact show the incremental contribution to energy supply for the most recent year, as global energy supply statistics are always lagging by ~2 years. So the most recent-year statistics on energy supply contribution growth are not available on a global basis. We certainly agree that those statistics would be valuable (and more useful than capacity growth), however, so we now note the situation in a footnote so that the reader at least understands the limits to capacity growth statistics such as those noted here. We have also made it clear that the RE contribution to electricity supply in ~20%, to provide needed context.
4442	7	33	3	33	16	How is maturity being defined in this paragraph?	Accepted - the definition is as noted already "level of technical and economic maturity to be deployed at significant scale". In other places we focus on technical maturity alone. While there is no single definition of maturity that is unambiguous, we have sought to be more clear on where we are focusing on technical maturity, and where we are also bringing in economic maturity.
13212	7	33	3	33	4	This sentence might be misunderstood : actually the solar cells improvements are not sufficient for putting PV at a "level of technical and economic maturity". I suggest deleting at least the first words "As a result of these and other advancements"	Accepted - excellent point
10537	7	33	5			IPCC 2011a better here than IPCC 2011 b	Accepted
9651	7	33	6	33	9	what about waste to energy? The relationship between bioenergy and food security needs to be mentioned somewhere.	Rejected - bioenergy encompasses waste to energy as per the IPCC SRREN. Food-bio links are addressed in chapter 11, and are not best addressed in the present section due to space constraints.
2586	7	33	6	33	8	Bioenergy: R&D is proving the economic use of some drought resistant plant such as Jatropha for biofuel production. Since this specie can be grown in arid zone, it can be used as green barrier against desertification; a n impact of climate changes	Rejected - noted, but too much detail to be included here given severe space constraints
17366	7	33	7			biomass-fuelled power plants and...	Accepted

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4648	7	33	8	33	8	See my comments above concerning lignocellulose-based transport fuel.	Noted
15946	7	33	9	33	16	solar pv is 'mature', and onshore wind is 'relatively mature'? Look at the numbers and the deployment and the LCOE. Wind is at least as 'mature' as pv.	Accepted
16040	7	33	9			(e.g. fuels, hydrogen or methan produced from ...	Rejected - it seems to us that fuels is a sufficiently broad term to encompass the suggested additions, and we are under space constraints
18058	7	33	17	33	24	Delete the section. The first sentence about cost having historically been above market prices 1) holds for all technologies - not only RE and 2) confuses cost and prices. For over a decade, this has held true for all new technologies and still does, as most countries in the world are still operating with regulated prices for energy poverty reasons. The second sentence is dubious in stating that RE technologies must be located where the resource is (implying far away from consumption), but failing to acknowledge that there are RE resources in some form in almost every location of the world.	Rejected - these points are quite directly made in the SRREN, and we believe they provide important links to other sections of the chapter in which related issues are addressed. While some wording changes have been made to this text based on this comment, and of course others as well, we believe the basic content here is accurate and important to maintain, especially in light of how important these types of statements are to many other comments received.
3454	7	34		34		Figures presented in the table are for developing countries, developed countries or world average?	Accepted - Table caption was revised to include the word "global"
11764	7	34				Many RE are extremely low operating rate and uncontrolable so groth in RE Deployment in table 7.4 should be evaluated by not only GW but GWh.	Accepted - we cannot in fact show the incremental contribution to energy supply for the most recent year, as global energy supply statistics are always lagging by ~2 years. So the most recent-year statistics on energy supply contribution growth are not available on a global basis. We certainly agree that those statistics would be valuable (and more useful than capacity growth), however, so we now note the situation in a footnote so that the reader at least understands the limits to capacity growth statistics such as those noted here. We have also made it clear that the RE contribution to electricity supply in ~20%, to provide needed context.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10656	7	34				Also Provide GWh information because in case of renewable energy the capacity factor is very low. GWh is more important.	Accepted - we cannot in fact show the incremental contribution to energy supply for the most recent year, as global energy supply statistics are always lagging by ~2 years. So the most recent-year statistics on energy supply contribution growth are not available on a global basis. We certainly agree that those statistics would be valuable (and more useful than capacity growth), however, so we now note the situation in a footnote so that the reader at least understands the limits to capacity growth statistics such as those noted here. We have also made it clear that the RE contribution to electricity supply in ~20%, to provide needed context.
4650	7	34		34		To put the RE growth in context, it would be good to include biomass heat energy which have an estimated 2% growth (P. 18, line 15). The respective numbers for 2009, 2010 and 2011, in million t of wood equivalent (energy value 18.7 GJ/t), are: 935; 954; 973. [50EJ, 51EJ, 52 EJ].	Rejected - somewhat related data provided earlier, so there is no need to repeat them due to space constraints. Additionally, the focus here is on modern form of RE.
7786	7	34		34		Section 7.5.5 mainly explains risks and uncertainty about the use of nuclear power such as resource sustainability, disposal of high level waste while it touches upon little about the current role of nuclear power in relation to the mitigation. As this section 7.5 is about analyzing mitigation technology options, practices and behavioural aspects, author should also analyze the nuclear power as an existing example of low carbon power resource in commercial use whose share is 7.4% (IAEA, "Energy, Electricity and Nuclear Power Estimates for the Period up to 2050", p.17, 2011) of global power generation.	Taken into account - 7.11 addresses nuclear response to climate mitigation efforts.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5928	7	34				Presenting only capacities gives a biased picture of the development: annual full-load hours of solar pv are often about 1000 h, wind 2000-2500 h, whereas for conventional generation at about 5000-6000 h in baseload operation and up to 8000 h for nuclear.	Accepted - we cannot in fact show the incremental contribution to energy supply for the most recent year, as global energy supply statistics are always lagging by ~2 years. So the most recent-year statistics on energy supply contribution growth are not available on a global basis. We certainly agree that those statistics would be valuable (and more useful than capacity growth), however, so we now note the situation in a footnote so that the reader at least understands the limits to capacity growth statistics such as those noted here. We have also made it clear that the RE contribution to electricity supply is ~20%, to provide needed context.
3787	7	34	13	34	16	Improve Figure 7.11 layout	Comment does not refer to 7.5.5
18061	7	34	16	34	16	Stating that nuclear contributes "significantly" in "many" nations is an exaggeration. 31 of 204 countries (15%) in the world has nuclear energy. However, it is only in a handful of those 31 nations that it contributes "significantly", depending on how "significantly" is defined.	Accepted - "significantly" removed
15490	7	34	16	34	16	Delete "many" (with regards to the real number of countries and the total share expect for some countries like France)	Accepted - text revised, "many" removed
10539	7	34	16	34	22	Repetition from 7.2 - so also merge	Taken into account - Repetitive nuclear text in Section 7.2 removed
17388	7	34	17	37	18	From line 17~18, "...There are 433 commercial nuclear power reactors operating in 30 countries with a total installed capacity of 367 GWe as of October 2011 (IAEA, 2011)". I strongly suggest that the statistical numbers should be updated to the end of year 2011, which could and should be available at this time of report editing. I think the current data were given earlier for this FOD version due to unavailability of year-end statistics. In addition, this part should better capture the latest state of nuclear developments in the world, particularly the post-Fukushima policy shifts in some major nuclear power countries. According to the news of "Japan unveils plan to phase out nuclear power" by the BBC on Sept 14, 2012 ( <a href="http://www.bbc.co.uk/news/world-asia-19595773">http://www.bbc.co.uk/news/world-asia-19595773</a> ), the Japanese government plans to shut down the reactors completely by 2040 and seeks to shift to renewable options or fossil imports (gas, oil and even coal). Such new policy changes would cause a significant impact on future nuclear deployment.	Accepted - Data updated with IAEA 2012. Nuclear policy in Japan is uncertain.
18062	7	34	18	34	18	replace "14%" with "13%" (according to the table)	Accepted - replaced with IEA 2010 data.
18063	7	34	21	34	21	delete "more than half". It seems odd to write more than half when it is more than two thirds	Accepted - text revised
17368	7	34	21			two-thirds (68%)...	This applies to Section 7.5.5 Editorial - text revised
16042	7	34	21	34	22	they represent 68% of the current ....	Accepted - text revised

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
12544	7	34	7			“Other more revolutionary small modular reactors (SMR) with additional passive safety features are near commercial status” -- this is simply untrue, if “near” means deployable in less than a decade at an affordable cost. The NRC does not anticipate online operation of any SMR design types prior to 2022. U.S. Nuclear Regulatory Commission, 2012. Report to Congress: Advanced Reactor Licensing. <a href="http://pbadupws.nrc.gov/docs/ML1215/ML12153A014.pdf">http://pbadupws.nrc.gov/docs/ML1215/ML12153A014.pdf</a>	This applies to Section 7.5.5. Taken into account - text revised
3786	7	34	8	34	14	What about sugar cane or sweet sorghum that produces simultaneously liquid fuel for transport and electricity for the grid?	Comment does not refer to 7.5.5
9229	7	34	14	34	15	To Incorporate three rows: Fossil electric power capacity above RE electric power capacity; gasoline demand or production below the row "ethanol production" and Diesel below the row of biodiesel production, to compare the share and dynamic	Rejected - space constraints preclude us from expanding the table, and data availability may be an issue. The contribution of RE electricity in % terms are now mentioned earlier in the text, however, to provide some of the needed context.
4780	7	34	4	34	5	It is important to note that storage hydropower and geothermal (as well as biomass under certain circumstances) are controllable renewable technologies that enhance the deployment of other variable renewables such as wind and solar. A sentence providing this information may be relevant.	Rejected - Good points, but addressed in the later section on infrastructure.
18066	7	34		37		In a report on the potential for climate mitigation, the timing of reductions should be addressed. This is particular true for nuclear fission and fusion as well as CCS. Due to the long construction and planning times, these technologies are to a great extent long-term mitigation options that will not have significant impact on GHG reduction within the window in which AR5 says we need to reduce emissions. In fact, one must expect that the net carbon reductions from nuclear power will be negative as more plants are retired than new plants brought online, at least in the coming decade.	Rejected - not supported by current use of nuclear power nor historical deployment rates. Disagree that nuclear fission is a long term option. They are operating today and contribute to emissions reduction, and many are currently under construction. Historically, most of the US power plants were deployed in 15 years.
18511	7	34				Much of the text in this section covers risks associated with nuclear technologies. It is important that this is covered, but the reader would expect it in 7.9, where indeed much of the same discussion appears. To save space, shorten here to focus on the technology and merge the risks discussion with that in 7.9.	Rejected - 7.5.5 covers current nuclear status and plans, and the impact of current nuclear technologies on the fuel cycle. Nuclear fuel cycle and nuclear energy use are inherently tied. There is minimal discussion related to nuclear risk factors.
7125	7	34	23	37	2	The content in these paragraphs does not seem to focus more on "Mitigation technology options, practices and behavioural aspects". These paragraphs could be trimmed or some of the material moved to section 7.4.2 to serve as background material for Resource and resource availability for nuclear	Rejected - All aspects of the nuclear fuel cycle is inherently tied to nuclear energy as a viable mitigation option. Some aspects of the fuel cycle must be discussed to provide context for nuclear energy production and use. Nuclear response to climate mitigation policies addressed in 7.12.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16117	7	35	1	35	6	Improved safety of EPR reactors is not proven because : none is operating and the record is nil; the size of the fuel charge is higher than any other civil reactor and thus inherently more problematic; safety is still depending on active measures and human responses. This paragraph should be more balanced.	Rejected - existing text uses the words "designs" and "features" and does not say that new LWRs are proven.
15947	7	35	17	35	17	the PBMR project in South Africa was abandoned years ago - and they were never 'developing' it. They were trying to get someone to pay for one. They had no takers.	Taken into account - text revised
16817	7	35	20			Suggest adding to end of paragraph: "the promise of "manufacturing" major components in this manner carries the possibility of beneficial learning curve impacts driving costs down significantly."	Taken into account - text revised
9504	7	35	25	35	27	Supply of uranium is enough for the future. So the text should be replaced like below. "the world has identified total resources of 5.4 million tons of uranium (available at a cost less than USD 130 per kgU), enough to last for 100 years at recent demand. Moreover, the IAEA notes that these figures include officially reported resources only, and that the potential is much higher as some countries do not report." [1]IAEA (2010) "Red Book – Uranium: Resources, Production and Demand," presentation at the RAF3007 Workshop on Uranium Data Collection & Reporting, July 2010(attached on email)	Taken into account - Resource issues addressed in 7.4.2. Text modified.
11934	7	35	26			"ore" grades	Editorial - corrected
16119	7	35	30			Use of the word "recycling" should not be used here to describe chemical reprocessing of nuclear waste. In France, the only country in the world to claim the whole cycle of reprocessing, actual use of waste materials amounts to only a few percentage points according to NGOs, and 12% according to the official Haut Comité à la Transparence et à l'Information sur la Sureté Nucléaire ( <a href="http://hctsin.fr">http://hctsin.fr</a> ) in a 2010 report. It is a far cry from the 96% claimed by the French firm AREVA.	Rejected - Do not see a problem with the text as written. Text does not comment on the degree to which recycled materials are utilized.
4110	7	35	45	35	45	More on the thorium fuel cycle and its perceived advantages over uranium would be useful.	Rejected - Limited by page allocation constraints to discuss additional fuel cycles.
17225	7	35	5			Cummins et al is not peer reviewed literature.	Rejected - referenced paper provides technical information on the safety features of AP1000 not available in peer reviewed literature.
17226	7	35	5			Is Goldberg counted as peer reviewed literature?	Taken into account - referenced report provides useful comprehensive information on Gen II and III and small modular reactors that is not available in peer reviewed literature. Additional references added.
18064	7	35	5	35	5	add "and higher costs" after "features"	Rejected - Costs are addressed in 7.8.2.
16118	7	35	7	35	20	Gas cooled reactors are not inherently safer or cheaper, nor in a good industrial trajectory this part is misleading and should be removed. See "Thomas S. 2011, the pebble bed reactor : an obituary" Energy Policy 39 (2011) 2431–2440)	Taken into account - text revised
17227	7	35	8			Kuznetsov is not peer reviewed literature.	Taken into account - replaced with IAEA report.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13494	7	35	41	35	42	Text : "Partial recycling of used fuels, such as the use of mixed oxide (MOX) fuels where U-235 in enriched uranium fuel is replaced with recycled or excess plutonium already contributes to improved uranium resource utilization and waste minimization efforts". MOX processing is not without its problems, and in some cases has been abandoned (for example, Sellafield in the UK).	Taken into account - text modified. That paragraph ends with reprocessing drawbacks of higher cost, associated complexities and proliferation concerns. The paragraph as a whole is balanced.
13495	7	35	44	35	47	Text : "Ultimately, full recycling options based on either uranium or thorium fuel cycles that are combined with advanced reactor designs where only fission fragments are relegated as waste can significantly extend nuclear resources and reduce high level wastes (GIF, 2002)." No option is without its waste disposal and security risks. The storage and treatment of "low level radioactive waste" is frequently omitted in assessing novel reactor designs. Plus the toxicity of some of the fission products of alternative reactor designs has its own unique risk profile. The "fallow" time needed for core development, before energy production can begin, for some of the alternative fission reactor designs, will almost certainly make it harder to attract project financing than it currently is.	Taken into account - the following text "Higher economic costs and complexities of advanced fuel cycles and reactor technologies are current drawbacks. Potential access to fissile materials from widespread application reprocessing technologies further raises proliferation concerns. The advantages and disadvantages of alternative reprocessing technologies are under investigation." provide balance.
13493	7	35	7	35	20	Text: "Other more revolutionary small modular reactors (SMR) with additional passive safety features are near commercial status (Kuznetsov, 2008; Rosner and Goldberg, 2011; World Nuclear Association, 2012b). The size of these reactors is typically less than 300 MWe and much smaller than the 1000 MWe size of current LWRs. Their lower power density, large heat capacity, and heat removal through natural means contribute to their improved safety. SMRs based on light-water designs rely on the substantial experience with current LWRs and utilize existing fuel cycle infrastructure. Light water SMRs from Russia, South Korea, and US are near commercial status. Gas-cooled SMRs, in addition to their passive safety features, have higher operating temperatures for increased electricity generation efficiencies relative to LWRs and potential industrial applications as a source of high temperature process heat (EPRI, 2003; Ming Zhang et al., 2009). Gas-cooled SMRs are under development in China, France, South Africa, and US. In general, smaller reactors that can be constructed in a factory setting with modular construction techniques and flexibility for incremental additions to total power capacity could shorten the duration of construction periods and improve the quality and economics of new nuclear plants (Rosner and Goldberg, 2011)." This paragraph reads like sales material, which does not convince me of the neutrality of the references cited. As a result I have doubts about the development of small modular reactors, and would be concerned about unmentioned aspects of their operation, including the disposal of waste and security from attack.	Taken into account - text revised and new references added. Added "the widespread applicability of SMRs remains yet to be determined." The text states that light-water SMRs utilize existing fuel cycle infrastructure, and does not comment on waste and security.
4443	7	36	20	36	28	The discussion on the Japan earthquake could be omitted as there have been discussions on nuclear safety on p34 and later on p36.	Rejected - this particular discussion of Japan nuclear accident is not redundant to other sections, and serves to provide context for future nuclear deployment.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4111	7	36	20	36	20	It should be stressed that if the retaining wall had been built higher, or if the Fukushima plant had not been placed so close to a tectonic plate and the ocean, and if proper maintenance had been done by Tepco over the years there would have been no nuclear accident. In this sense it was not a failure of a nuclear system, but a wider systemic failure.	Taken into account - The text as written states that the "earthquake" and "tsunami" caused the accident. It does not state that there is a failure of nuclear system. 7.9.3 also states that "causes" are "fundamentally different".
15464	7	36	20	36	40	It may be useful to mention somewhere in this section that in a dramatic shift away from policies that strongly supported the nuclear industry in Japan a "Cabinet panel on called for Japan to phase out nuclear power over the next three decades" <a href="http://www.washingtonpost.com/business/ap-interview-japan-nuke-probe-head-defends-report-that-didnt-blame-individuals-for-disaster/2012/09/13/c097b2f2-fe0c-11e1-98c6-ec0a0a93f8eb_story.html">http://www.washingtonpost.com/business/ap-interview-japan-nuke-probe-head-defends-report-that-didnt-blame-individuals-for-disaster/2012/09/13/c097b2f2-fe0c-11e1-98c6-ec0a0a93f8eb_story.html</a>	Rejected - Nuclear policy in Japan is uncertain
10541	7	36	20	36	28	Also suggest to standardise the order of technologies discussed in each section to become the same for better readability e.g. coal/oil/gas/nuclear/RE/CCS	Accepted - sequence has been standardized: fuel shifting, RE, nuclear, CCS
11935	7	36	21			should say "due to a loss of back-up power	Rejected - Unnecessary.
9592	7	36	22	36	24	Please, describe accurately the fact about Fukushima as two accidents differ in degree; France's national nuclear regulator IRSN published a comprehensive report in 2012 on the radioactive releases from the Fukushima accident. It found that the releases of radioactive iodine isotopes (of which iodine-131 is one of the most significant in terms of environmental and dosimetric impact) were on the order of a few hundred PBq, which is around ten times lower than the Chernobyl accident [1]. It also found that releases of cesium-137 (which will persist the longest in the environment with its half-life of 30.1 years), were estimated to be 21 PBq, accounting for around one-fourth of the cesium-137 released by the Chernobyl accident [2]. [1] IRSN (2012) "Fukushima, one year later: Initial analyses of the accident and its consequences," March 12, 2012 [2] IRSN (2012) "Fukushima, one year later: Initial analyses of the accident and its consequences," March 12, 2012 ( <a href="http://www.irsn.fr/EN/publications/thematic/fukushima/Pages/overview.aspx">http://www.irsn.fr/EN/publications/thematic/fukushima/Pages/overview.aspx</a>	Taken into account - text revised. Reference to Chernobyl removed.
11766	7	36	24	36	26	As long as seeing next paragraph, nuclear deployment activities are still on-going around world. [some nations] is more appropriate.	Accepted - text revised
9505	7	36	24	36	26	Many countries are progressing the nuclear energy development, only Germany changed the policy. This text should be deleted.	Taken into account - text revised
10657	7	36	24	36	26	Disagree. There is more nations who promote nuclear energy than abandon it.	Taken into account - text revised.
18065	7	36	26	36	26	write "for many of the nations that utilise nuclear power" (it is in relatively few of the 204 nations in the world but in many of the 31 nations that have nuclear power).	Taken into account - text revised.
16043	7	36	26			Ad: Germany has decided to get out of the use of nuclear energy to the end of 2022 and Japon within the 2030th	Rejected - Nuclear policy in Japan is uncertain.
10043	7	36	26	36	28	The list of countries who abanded nuclear programms is not complete. Countries like Belgium and Switzerland are currently discussing a nuclear phase	Rejected - Italy has no nuclear capacity. "Several nations" are used to include other countries. Nuclear capacity in Belgium and Switzerland are relatively smaller than Japan and Germany.
7734	7	36	27	36	28	The rsonse was that Japan has decided not to continue to pursue nuclear power as a source of enegy for the country.	Rejected - Japan nuclear policy is uncertain.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
7735	7	36	29	36	31	For those nations, like Japan who has suffered immensely from the accident, populations have been strongly opposing to nuclear energy. This whole section could have been written in a way that convince people that nuclear energy is not to be used. However, it is not expected that scientific work takes this role. The current section is biased to show that nuclear problems have been or are about to be solved, which is not true. Please, access the risks of using this type of source of energy, which has been left out of the text, surprisingly.	Rejected - Risk of nuclear energy use covered in 7.9.
16818	7	36	31			Suggest adding after " ... of power supplies." the following text: "Energy System modeling continues to show that nuclear technology provides one of the lower cost options for lowering CO2 emission from electricity generation."	Taken into account - Nuclear cost competitiveness addressed in 7.8. Additional text added to recognize nuclear option for lowering CO2.
5157	7	36	39	36	39	emerging nations ? Rephrase?	Taken into account - text revised
17228	7	36	4			The paragraph should discuss also the issue with a perspective to international policies.	Rejected - comment not clear. See 7.8 for nuclear cost, 7.9 for nuclear risk, and 7.12 for nuclear response to climate policy.
9473	7	36	41	36	44	It should be described that nuclear power is one of the generation technologies that produces the least GHG emission in life cycle and have contributed to prevention of global warming.	Taken into account - text revised. Nuclear response to climate change policy covered in 7.12.
11767	7	36	41	36	44	Ameding to [Nuclear power has been around for five decades or more. Meanwhile it would be still cost effective compared with others(Tidball et al. 2010), unresloved issues remain for the .....] would be ballancing. 1.R. Tidball et al.:[Cost and Performance Assumptions for Modeling Electricity Generation Technologies], send attachment by another e-mail.	Taken into account - text revised. Cost discussion covered in 7.8. Nuclear response to climate change policy covered in 7.12.
9593	7	36	41	36	44	All forms of generation face unresorolved issues and nuclear is deployed in various reasons, including climate change mitigation. Please, rewrite here by using following information; nuclear power is stemmed from the need to cost-effectively satisfy rapidly growing electricity demand in the emerging economies, as well as efforts to achieve energy and environmental policy objectives, including mitigating greenhouse-gas emissions and providing a secure, diversified and lowcost electricity supply. (WEO 2011, IEA)	Taken into account - text revised. Electricity demand and energy diversity referred to in earlier paragraph. Nuclear response to climate change policy covered in 7.12.
10658	7	36	41	36	44	Nuclear economics have greatly improved.	Rejected - not supported by publically available cost data. See discussion on cost in 7.8.
13198	7	36	41	36	43	This statement is policy prescriptive and no justification is given for asserting that nuclear power is not presently a valid option for climate change mitigation. See a recent paper by R. Dautray, J. Frieddel and Y. Bréchet Nuclear energy in France today and tomorrow: IInd tio IVth generations, , C.R. Physique 13 (2012), 480-518, for a serious scientific analysis of this topic.	Taken into account - text revised for balance. Text does not say that nuclear is not a valid option. Nuclear response to climate change policy covered in 7.12.
9995	7	36	41	36	44	This part should be revised 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).  <Reference> [1]Weisser, D. (2007). A guide to life-cycle greenhouse gas (GHG) emissions from electric supply technologies. Energy, Volume 32, Issue 9, Pages 1543-1559.	Taken into account - text revised to include nuclear contribution to emissions reduction. Nuclear cost competitiveness addressed in 7.8.
17750	7	36	42			delete "CCS and"	Comment misplaced. Not in nuclear section.

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16819	7	36	43			Re "resource sustainability" -- resources to build nuclear or any other technology is included in the economic calculations for the source. "Resource sustainability" is not well defined or understood. Does it take into account what we know from resource economics?	Taken into account - text revised
5929	7	36	9		10	In Finland, the Posiva's final waste deposit Onkalo is under construction and progressing according to plans.	Taken into account - text revised.
13496	7	36	24	36	28	Text : "The severity of the nuclear accident in Japan has brought about a reinvestigation of nuclear energy policy and deployment activities for many nations around the world, most notably in Japan and Germany. The response to the accident has been otherwise mixed and its full impact may not be realized for many years to come." The Fukushima Dai-ichi 3/11 ongoing accident was not an unique failure in nuclear power plant management. There have been regulatory problems regarding safety, modifications, repairs and servicing of nuclear power plants for some time, particularly in Japan, France and the US. There are regular unplanned outages reported in the press, and sometimes media coverage of administration problems. Two important examples of ongoing issues include the February 2011 reports of problems with control rods (Perry Nuclear Plant, GE Hitachi, Marathon control rods <a href="http://starbeacon.com/local/x789958596/Perry-Nuclear-Plant-monitoring-defective-control-rods">http://starbeacon.com/local/x789958596/Perry-Nuclear-Plant-monitoring-defective-control-rods</a> ) and September 2011 potential problems identified for scram in a seismic event (20 - 30 US reactors, GE Hitachi, NRC <a href="http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2011/20110928en.html">http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2011/20110928en.html</a> ). Reports into the Fukushima Dai-ichi multiple reactor accident concluded that failures in human systems were to blame - a "man-made disaster" ( <a href="http://icanps.go.jp/eng/final-report.html">http://icanps.go.jp/eng/final-report.html</a> <a href="http://icanps.go.jp/eng/07V1final.pdf">http://icanps.go.jp/eng/07V1final.pdf</a> <a href="http://fukushima.ans.org/report/Fukushima_report.pdf">http://fukushima.ans.org/report/Fukushima_report.pdf</a> ). Belgium is to consider the decommissioning of two reactors with extensive cracking : Tihange 2 and Doel 3, and this move may prompt similar consideration elsewhere, as case cracking is apparently prevalent with reactor age. There is an ongoing demand to improve venting in containment vessels in the USA (NRC, March 2012, order to all Mark I and Mark II reactors). The promotion of a nuclear power "renaissance" is losing its power to convince.	Rejected - The Nuclear Energy section does not mention nuclear power "renaissance" and comments on current activities. Historical capacity factors for nuclear plants have increased. No power plant is designed to last forever. All nuclear reactors have design lifetimes.
10050	7	36	26	36	27	add all countries who reacted with specific measure such as Italy (abandoned nuclear plans), Belgium (stalled plans) etc,	Rejected - "nuclear energy policy and deployment activities for several nations" are used to include other countries. Italy has no nuclear capacity. Nuclear capacity in Belgium and Switzerland are relatively smaller than Japan and Germany. Need to balance response to Fukushima.
3397	7	37		37		Delete text. Empty of relevant content: From line 5-8 and from lines 32-43.	Taken into account - comment is obsolete as most of the text has been deleted due to space restrictions. The entire section 7.6.1 has been rewritten und shortened considerably

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3398	7	37		41		Remaining text (page 38 to 39) can be drastically reduced as it only introduces trivial and well known ideas and a large number of references. Factual figures and quantitative information should be preferred in IPCC reports: section 7.6.1 is very poor (it's rhetoric, and abuses of trivial messages and references (see for example page 40 lines 33 to 47, including a reference to claim for Sims et al (2007, 2011) the "discovery" that electricity has to be transported for considerable distances; j i j ) . Section 7.6.2 is a perfect example of a high quality job..... EFFECTIVE CROSS-REVIEW BETWEEN LAs HAS TO BE ENCOURAGED IN THE SOD	Taken into account - comment is obsolete as most of the text has been deleted due to space restrictions. The entire section 7.6.1 has been rewritten und shortened considerably
12592	7	37				Other issues with renewables in the grid will include: real power fluctuation, reactive power generation and absorption, voltage dips, and voltage harmonic distortions. Please see Chen, Z., Spooner, E., "Grid power quality with variable speed wind turbines", Energy Conversion, IEEE Transaction on, 2001, Vol 16, Issue 2, pages 148-154	Rejected, - power quality has not been a major barrier in areas that have increased the supply of variable RE.
12593	7	37				Some more detail on infrastructure would be good. For example, substation issues, of which one solution is fault current limiters.	Rejected, seems too detailed of a point for this broad discussion that other reviewers has insisted is cut down.
12595	7	37				Superconducting magnetic energy storage can also be used for grid quality issues	Rejected, minor point and might be misunderstood.
12603	7	37				Peak energy demand is also effected by heat pumps on defrost cycles and electric cars in localised areas – this needs to be sorted	Taken into account - comment is obsolete as text has been deleted due to space restrictions
16820	7	37	17		22	Is this paragraph redundant with the previous paragraph?	Taken into account - comment is obsolete as most of the text has been deleted due to space restrictions. The entire section 7.6.1 has been rewritten und shortened considerably
2833	7	37	21	37	22	In a liberalised market, the challenges are mainly to do with market and pricing structures, risk and reward, operating regimes etc.	Taken into account - comment is obsolete as most of the text has been deleted due to space restrictions. The entire section 7.6.1 has been rewritten und shortened considerably.
16821	7	37	23		31	The claim that there are no technological limits to how much RE can integrated into energy system overlooks or does not sufficiently consider the growing cost impact on the rest of the energy delivery system as the share of RE grows. The change in the base load system need to maintain reliability adds to the total cost of each additional unit of RE. See: <a href="http://www.purdue.edu/discoverypark/energy/assets/pdfs/Wind_Impact_Report.pdf">http://www.purdue.edu/discoverypark/energy/assets/pdfs/Wind_Impact_Report.pdf</a> and <a href="http://economics.mit.edu/files/6317">http://economics.mit.edu/files/6317</a> and <a href="http://ei.haas.berkeley.edu/pdf/working_papers/WP221.pdf">http://ei.haas.berkeley.edu/pdf/working_papers/WP221.pdf</a>	Taken into account - comment is obsolete as most of the text has been deleted due to space restrictions. The entire section 7.6.1 has been rewritten und shortened considerably
16044	7	37	25			targets, and in some cases increased transmission infrastructure. (in the case of more decentralized energy production including local and regional energy autonomy is need less transmission infrastructure.	Taken into account - comment is obsolete as text has been deleted due to space restrictions

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4444	7	37	29	37	31	It may be worth emphasizing the institutional barriers at this point – many countries are interconnected and accommodate large flows of energy between them.	Taken into account - comment is obsolete as most of the text has been deleted due to space restrictions. The entire section 7.6.1 has been rewritten und shortened considerably
16045	7	37	29			complexities and investment costs ...	Taken into account - comment is obsolete as text has been deleted due to space restrictions
16046	7	37	30			must adress existing institutional ...	Taken into account - comment is obsolete as text has been deleted due to space restrictions
2834	7	37	35	37	38	This section underplays the potential of the demand side in referring only to “any available flexibility” there. One of the main challenges is to encourage more demand-side flexibility, for which the potential is growing rapidly with advances in ICT, smart grids and so on. This whole area needs more detailed analysis.	Taken into account - comment is obsolete as most of the text has been deleted due to space restrictions. The entire section 7.6.1 has been rewritten und shortened considerably
18067	7	37	40	37	40	Paragraph should be completed with: However, increasing the size of a control zone or electricity market reduces the need for reserve capacity as balancing can be done over a larger area with an increased palette of assets. Increased flexibility, does not necessarily mean an increase in investments in reserve capacity. (or similar)	Taken into account - comment is obsolete as most of the text has been deleted due to space restrictions. The entire section 7.6.1 has been rewritten und shortened considerably
6789	7	37	3	43	19	It may be helpful to shorten, move and merge contents under section 7.6 to section 7.5.2. This move may be helpful to reduce the number of pages and yet retain the flow. Section 7.5.2 may be further renamed to appropriately reflect the revised contents.	Taken into account - comment is obsolete. Text has been deleted due to space restrictions.
9652	7	37				this sections is repetitive and can be shortened	Taken into account - comment is obsolete as text has been deleted due to space restrictions

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6437	7	37				<p>Since AR4 a number of authors have modelled 100% renewable electricity systems at half-hourly or hourly resolution, using historic data, and have demonstrated the technical feasibility of these systems. I recommend that these studies be included in the AR5 report. Denholm and Hand (2011) modelled hourly wind, PV (a mixture of fixed and 1-axis tracking) plus concentrating solar power electricity generation over the period 2005-2006. These authors demonstrated an inverse relationship between system flexibility and the curtailment of variable renewables. They showed that a poor observed correlation between wind availability and demand patterns could be improved by the addition of solar generation, with a resulting decrease in curtailment. Further reduction in curtailment by the addition of energy storage, and potentially demand response measures, was shown. Elliston et al. (2012) modelled a 100% renewable electricity generation system for Australia, at hourly resolution, for the year 2010. A generation mix comprising 27% (23.2 GW) wind, 17% (14.6 GW) PV, 18% (15.6 GW) CST with thermal storage, 6% (4.9 GW) hydro, 28% (24 GW) biomass and 2% (2.2 GW) pumped hydro energy storage (PHES) was found to be capable of supplying demand, consistent with existing standards. Mason et.al. (2010) demonstrated, at half-hourly resolution, how generation mixes comprising 53-61% hydro, 22-25% wind, 12-14% geothermal, 1% biomass and 0-12% additional peaking generation could provide a 100% renewable electricity system on an energy and power basis for New Zealand. Modelled systems were shown to provide security of supply, and to maintain net hydro storage, over a 3 year study period. In addition to these studies, several (apparently) non peer-reviewed but nonetheless robust studies (grey literature) demonstrated similar findings (Ackermann et al., 2009; Wright and Hearps, 2010; Troster et al., 2011; vandePutte and Short, 2011).</p>	Rejected - space constraints do not allow to go into the details.
6438	7	37				<p>Additional peer-reviewed references for section 7.6.1: Denholm, P. and Hand, M., 2011. Grid flexibility and storage required to achieve very high penetration of variable renewable electricity. Energy Policy 39, 1817-1830; Mason, I.G., Page, S.C. and Williamson, A.G., 2010. A 100% renewable electricity generation system for New Zealand utilising hydro, wind, geothermal and biomass resources. Energy Policy 38 (8), 3973-3984; 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. (Apparently) non-peer-reviewed reports for section 7.6.1: Wright, M. and Hearps, P., 2010. Zero Carbon Australia Stationary Energy Plan. Melbourne Energy Institute, University of Melbourne, Victoria, Australia; vandePutte, J. and Short, R., 2011. Battle of the grids. Greenpeace International, Amsterdam, The Netherlands; Ackermann, T., Troster, E., Short, R. and Teske, S., 2009. Renewables 24/7: infrastructure needed to save the climate. Greenpeace International, Amsterdam, The Netherlands; Troster, E., Kuwahata, R. and Ackermann, T., 2011. European Grid Study 2030/2050. Energynautics GmbH, Langen, Germany</p>	Rejected - space constraints do not allow to go into the details.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4355	7	37	3			I think the section on electrical power system misses an important challenge to renewables: It's not only balancing, resource adequacy, and grids: Fluctuating renewables fundamentally alter the distribution of residual load: there will be more hours with low residual demand and fewer hours with high residual demand at high penetration rates of wind and solar power. Subsection 7.6.1.1 discusses mainly intertemporal flexibility (regulating power, ramps, balancing services) - but even if these issues would disappear, a wind/solar-intensive power system would be substantially different than a conventional one (less capital intensive / more peak load technologies). In other words, I suggest to split the section and discuss "contingency flexibility" (short-term response, regulating power issues etc.) separately from "scheduled flexibility". While better forecasts of wind/solar power can decrease the need for balancing services, it is a fundamental property of these sources to be more available during some times than during others - and this fundamentally affects the requirements to the rest of the power system. For references see - 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 (2012): "The Market Value of Variable Renewables", USAEE Working Paper 2110237.	Taken into account - the point is accepted. New material has been added and there is more attention now to new loads and demand side management.
11936	7	37	32			This section should lead with a discussion of smart grids(many publications) and then get into integration of different types. Find it strange that smart grids are not mentioned until p.66. The discussion of RE is overly long and this section needs more balance	Rejected, smart grids were deliberately avoided as they mean different things to different people. There is a short note on smart grids at the end of the section.
10052	7	37	32	40	4	This section requires more work: The system conflict between baseload generation and flexible generation should be explained in more detail - the grid is described as a barrier, but in fact it is the way how the grid is used, not the grid itself. This should be made clearer in this section. The cables are the same in a flexible and in an inflexible grid - the grid management makes the main difference.	Taken into account - text has been rewritten considerably to clarify that point.
10674	7	38	1	37	2	Flexibility of CHP plants can also be improved through the addition of other heat sources such as network heat pumps see Kilmakommissionen. (2010). "Danish commission on climate change policy." Kilmakommissionen. Copenhagen. Denmark.	Accepted - text added.
9506	7	38	10	38	12	"many country" is vague expression. At least there is no regulation about the restriction of flexible operation. This text should be deleted.	Accepted - text changed.
16122	7	38	17			In this line, it is not clear if CCS may become part of the solution to improve flexibility of the system. In fact, the research tries mainly to avoid that CCS hampers flexibility. This is not the same. The sentence could read "Characterizing CCS flexibility in order not to prevent evolutions to a more variable system.. is an area of active research".	Accepted - I've added a phrase to help clarify this but since I don't fully understand the comment, may have done the opposite.
4817	7	38	19	38	27	I'm not convinced by the low variable cost argument	Accepted - now re-phrased.
13200	7	38	19	38	27	The intermittence of wind energy may pose to the network stability serious problems which are not clearly presented by the present phrasing, e.g. How to cope with a wind speed zero over a large geographic region, under anticyclonic conditions which may prevail during several consecutive days, even if such an event does not occur every year? Large investments in the network are necessary, for maintaining its stability, when the percentage of wind energy increases. Order of magnitudes should be provided, as far as possible	Rejected - we address the low capacity credit of wind in the Resource Adequacy section
5158	7	38	19	38	20	hydropower is extremely more flexible than bio and geo and should not be directly compared here - it is a central property of storage hydro to be able to dispatch on very short notice - the phrasing: "to some extent" is not correct	Accepted - text re-written to ensure that high degree of flexibility of hydro is recognized

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18069	7	38	22	38	22	Delete "highly".	Taken into account - comment is obsolete as text has been deleted due to space restrictions
18070	7	38	23	38	24	Delete "because output cannot be perfectly forecast". No technology can be perfectly forecast and they do not need to be for efficient system operation.	Taken into account - comment is obsolete as text has been deleted due to space restrictions
12545	7	38	25			Recent research indicates that geographically and type-diverse deployment of renewable resources will substantially decrease the need and cost of balancing reserves. Many other improvements can be made in grid operations to support more effective integration of renewable resources. GE Energy, 2010. Western Wind and Solar Integration Study. NREL/SR-550-47434. Lisa Schwartz, et al. 2012. Meeting Renewable Energy Targets in the West at Least Cost: The Integration Challenge. Report to the Western Governors' Association. <a href="http://www.westgov.org/index.php?option=com_joomdoc&amp;task=doc_download&amp;gid=1602">http://www.westgov.org/index.php?option=com_joomdoc&amp;task=doc_download&amp;gid=1602</a>	Rejected - this issue is covered adequately in Sims et al 2011 and space is limited here.
5138	7	38	27			the reference "Sims" should be properly cited.	Accepted - but most have been removed now.
4818	7	38	27	38	27	Thus increasing consumer bills which has an important social impact given the economic crisis	Rejected - not relevant here.
2835	7	38	28	38	32	Another, probably the, key strategy is improvements in market and pricing structures.	Taken into account - demand response is mentioned.
18072	7	38	28	38	32	Add changes in market operation and load control as strategies	Taken into account - demand response is mentioned.
18071	7	38	29	38	29	"access to flexible thermal plants" should be changed to "access to flexible thermal and / or renewable plants"	Taken into account - text revised.
4445	7	38	3	38	18	What is CCS flexibility? Under what scenarios would a CCS fitted to a conventional powerplant not be operated at full potential linked to plant throughput?	Rejected - references adequately describe conditions under which flexibility would be used/required
15478	7	38	3	38	18	this discussion is clearer than that on p 31; Pouret, L., N. Buttery and W.J. Nuttall (2009) "Is nuclear power inflexible?" Nuclear Future, vol. 5 no. 6, pp. 333-340 suggest that existing designs of PWR can flex down to 60% of output	Accepted - we already cite this reference but not this statement so have added it.
18068	7	38	3	38	18	It seems very odd that the section puts so much emphasis on a power technology (CCS) that will not be deployed at any significant scale - and thus will have little impact on system balancing - during the next decade, at least.	Rejected - we feel that it is better to include all of the options in the review, albeit briefly.
6439	7	38	3	38	18	Given the findings of the renewable electricity system modellers just mentioned, there is now good evidence that the inflexibility of nuclear and "fossil fuel with CCS" plants, will place significant limits the penetration of variable renewables and/or require their curtailment.	Taken into account - text revised.
4815	7	38	3	38	4	Relatively low variable costs: is this variable costs of operation or investment?	Accepted - text improved and clearer in this regard now
4816	7	38	3	38	4	Is there a technical constraint to build flexible nuclear plants? Because financially there is the incentive to operate them as hydro-storage plant which are able to capture high prices at peak time (on top of their base load profit) as they can ramp up quickly enough to enjoy these prices	Taken into account - comment is obsolete as text has been deleted due to space restrictions.
13199	7	38	3	38	18	While there is no doubt that nuclear power and CCS are capital-intensive, the related problems seem overemphasized ; while France produces 80% of its electricity through nuclear reactors, no difficulty has arisen. Moreover, why relating this problem to those two topics only, it's obviously the same for wind power :	Rejected - the comment is misleading but the issues are complex and would require much more text to deal properly with them. This section is now better and also includes more on nuclear flexibility.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9489	7	38	3	38	18	Reference to CCS should be made more specific whether CCS is done on gasfired or coalfired. Gasfired with CCS require smaller investments than coalfired and will in the future have a larger role to balance variations in a net with large renewable power. future development within gasfired with CCS will be towards more integrated solutions and also more compact with faster responses to variations in electric output .	Rejected - space constraints do not allow to go into every detail.
5930	7	38	3		41	Nuclear and CCS are both capital-intensive low-GHG technologies, and they need to be operated in baseload mode to be economically meaningful, as the authors mention. I think one key point is missing in this text: large amounts of variable generation (wind & solar) in the electricity system make investments in nuclear or CCS economically impossible. With a large penetration of variable RE, we have solar pv with annual full load hours of about 1000 h and wind with full load hours of 2000-2500 h. If the rest has to be provided by fossil back-up generation, then the possible GHG emission reductions from the system remain very modest.	Rejected - but please note improved phrasing.
6440	7	38	33	38		The previous modelling results confirm that penetration of variable renewables can be greater than 20% for at least two quite different scenarios (Mason et.al., 2010; Elliston et. al., 2011). This matter must be examined for each region or country and the emerging evidence is that provided storage is adequate, and that some small degree of energy spillage is accepted, variable renewables can be accommodated high levels. Advances in power point tracking technology make this increasingly feasible.	Taken into account - text revised.
9594	7	38	34	38	36	Please, describe here correctly as reference does not mention many regions, where balancing exceed 20% of total supply, but 7 regions, and not some regions, where balancing is above 40%, but two regions and one country. (IEA, 2011f)	Accepted - text changed.
4819	7	38	38	38	38	Note that new flexible generation will most probably be CCGTs in most countries which will increase GHG	Taken into account - comment is obsolete as text has been deleted due to space restrictions
2836	7	38	40			The word "modestly" here is misleading. Presumably (though the text is unclear) this is a reference to cycling costs rather than total back up requirements (which can have a very significant impact on emissions in a wind-dominated system). Even in regard to cycling some studies show significant emissions and cost implications (eg Denny and O'Malley enpol.2008.10.050 <a href="http://dx.doi.org/10.1016/j.enpol.2008.10.050">http://dx.doi.org/10.1016/j.enpol.2008.10.050</a> ).	Rejected - Denny and O'Malley were included in review in Wiser et al 2011, the penalty remains less than 10% in these studies and below 5% in some of them. It should be noted however, that the entire issue is challenging
16822	7	38	7		10	Low variable cost almost by definition make a resource base load -- why would any system operate a low variable cost unit intermittently?	Taken into account - the text is now clearer so this misunderstanding is probably dealt with.
10687	7	38	28	38	32	The importance of integrating information and communication technology (ICT) into power system management should be more explicitly stressed, since ICT is the key to realize secure communication, wide area monitoring, and intelligent control and so on, which are essential to realize smart grids. Load control (or demand response) is not only done to make demand follow the availability of supply in smart grids. Much study effort is being dedicated to better load control, by which the impact of variable renewable energy output can be mitigated without deteriorating the customer's comfort.	Accepted - demand response is clearly highlighted as an area of interest for providing flexibility. There is a short paragraph on smart grids at the end of section 7.6.1.
9653	7	38	3	40		CCS does not really fit into this section - might be better to have it in the section on CCS or on its own	Rejected - this section is about electrical system issues as a whole, so it should cover CCS too, albeit briefly.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4781	7	38	33	38	38	Reference to IEA, 2011f is relevant. However it is important to mention that figures provided for Denmark (Fig 7.11) assume huge interconnections and back-up from neighbouring countries, in particular the flexibility provided by Norwegian hydropower.	Accepted - text changed.
7736	7	39				Improve quality of image	Taken into account. Figure has been deleted.
4446	7	39		39		This figure could be re-drawn so the text is easier to read.	Taken into account. Figure has been deleted.
12033	7	39				Not only the technical potential but also marginal costs should be discussed in this kind of comparison. For example, wind power can be much cheaper in areas with good wind conditions than those in poor conditions since the efficiency co-relate cubics of average wind velocity.	Rejected - the point about increasing marginal costs of wind sites is important, but not relevant to this section
15948	7	39	10	39	13	Better than curtailment, is using surplus wind to heat up the boilers in central and district heating systems, as is done now in Denmark.	Accepted text revised.
15479	7	39	12	39	13	in a number of EU countries, regulations strongly discourage system operators from constraining off wind power, and the support mechanisms used can force the system operator to pay the opportunity cost of subsidies foregone rather than the (near-zero) marginal cost of turning down the station	Rejected - although this is correct policy aspects and regulation issues are not discussed here due to space constraints. The section is on technical aspects only.
9654	7	39	13			Figure is blurry and difficult to read	Taken into account. Figure has been deleted.
16121	7	39	17	40	4	Important paragraph that shows the system combinations are the key issue and not the choice of one source.	Noted.
6450	7	39	17	40	4	I strongly concur with the analysis and conclusions in this paragraph and suggest this represents important progress since AR4, which should be mentioned in the executive summary	Rejected - although it is correct, not every aspect can be included in the ES.
2782	7	39	3	39	7	Pumped hydro is not the only one. Also compressed air is used commercially e.g. in Germany. However, despite having both pumped hydro and compressed air storage in the power grid, the storage capacity in the German power grid is only 0.04 TWh. But storage capacity of the German gas grid is 217 TWh. Storage of wind power will begin in the German gas grid as wind methane in 2013. The same way also solar and wave power can be stored making very high share of intermittent power generation in power consumption possible. In addition, this technology makes it possible to use large amount of wind, solar and wave power in transport in methane vehicles (this is also Chapter 8 issue, see comment 38).	Taken into account - comment is obsolete as text has been deleted due to space restrictions
13037	7	39	3	39	5	While pumped storage is indeed a major contribution to energy storage at large scales, this assertion neglects the fact that conventional storage hydropower is also a storage technology. I.e., pumped storage is only needed when traditional storage reservoirs are not available. It is not reasonable to build pumped storage unless you have no option to build a storage hydropower facility. The statement could be improved by rephrasing as follows: "Outside of conventional storage hydropower, to date, pumped hydropower storage is the only power storage technology deployed at a large scale, with 300 plants amounting to 95 GW worldwide."	Accepted - text revised.
16823	7	39	3			suggest you add to end of sentence after Borentstein and Centolella references" "although the difference between the high price time of day vs. low price time of day price shrinks during periods when natural gas prices are very low.	Taken into account - comment is obsolete as text has been deleted due to space restrictions

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5159	7	39	3	39	5	in regard to large scale: it could be mentioned that ordinary storage hydro has the ability to balance variable sources - ref Norwegian systems balancing Danish wind production; SRREN chapter 5.5.4 - "the only power storage technology--- " is misleading. The previous sentence talks about energy storage. Storage hydro should be mentioned as an energy storage and an energy source, while pumped storage is only storage not a source. Propose to insert: To date, "storage- and " pumped hydropower storage is the only ----. the number of plants (300 will, however, need to be corrected if Storage HP is included - or a new sentence after scale; "Presently 300 pumped storage HP plants are applied worldwide." -- ?	Accepted, Revise to indicate that both hydropower storage and gas storage currently play a big role, but distinguish this from storage that relies on the grid for charging
10542	7	39	3			Add to end of storage sentence "but usually at a relatively high cost." Could reference Sims et al 2011	Taken into account - text revised.
10069	7	39	5			In 2010 EPRI published a Report Electricity Energy Storage Technology Options (No 1020676) and gave an estimate of 127 GW; The IRENA Working paper Volume 1: Power Sector, Issue 3/5 cites the International Hydropower Association (IHA) (2011), IHA 2010 Activity Report, IHA, London with an estimate of 120 to 150GW. It would be good if a range could be given here as well.	Taken into account - comment is obsolete as text has been deleted due to space restrictions
12594	7	39	6			I think storage needs to be discussed more – include a mention of redox batteries, superconducting energy storage and flywheels. Happy to provide summaries if necessary.	Rejected - further detail regarding storage left to reference to Chapter 8 of SSREN
6449	7	39	6	39	7	Additional references for compressed air energy storage: Pickard, W.F., Hansing, N.J. and Shen, A.Q., 2009. 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., 2009. 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.	Rejected - no space to add this level of detail.
10051	7	39				Figure is misleading as it does not reflect the reason why technical capability is low: A large share of baseload power plants in the grid is a constrain for RE - not the grid itself.	Taken into account. Figure has been deleted.
13497	7	39	10	39	13	Text : "Finally, if surplus renewable supply exists despite the best efforts of system operators, renewable energy generation can be curtailed by switching off unwanted plant or through regulation of the power output. Indeed curtailment of wind power is common practice where and when transmission constraints prevent full utilization of available wind." There is scope for using unused wind and solar power for such things as the production of Renewable Hydrogen through electrolysis, and for heating banks of molten salts. These can be later employed as back up - such energy stores could be used to smooth and extend the output of a wind or solar farm for times when the wind is not blowing, over-blowing, or when solar generation is impossible - at night.	Accepted - text added.
13498	7	39	19	39	21	Text : "Base-load operation of CCS and nuclear plant, on the other hand, is of little concern from a system balancing perspective up to the point where the capacity of nuclear and CCS approaches the minimum net load of the system." Not included in this analysis is the problem of outages, both planned and unplanned. There will always be a need to have back up - even for generation considered as "baseload". Studies on the "supergrid" concept, and others, show that with a sufficiently geographically-widespread and integrated system of renewable electricity generation, balancing capacity and output is very achievable ("Saturation wind power potential and its implications for wind energy", by Mark Z. Jacobson and Cristina L. Archer, 2012, <a href="http://www.pnas.org/cgi/doi/10.1073/pnas.1208993109">http://www.pnas.org/cgi/doi/10.1073/pnas.1208993109</a> ; Gregor Czisch, "Scenarios for a Future Electricity Supply: Cost-Optimised Variations on Supplying Europe and Its Neighbours with Electricity from Renewable Energies" <a href="http://www.theiet.org/resources/books/renewable/scenarios.cfm">http://www.theiet.org/resources/books/renewable/scenarios.cfm</a> , <a href="http://www.iset.uni-kassel.de/abt/w3-w/projekte/LowCostEuropEISup_revised_for_AKE_2006.pdf">http://www.iset.uni-kassel.de/abt/w3-w/projekte/LowCostEuropEISup_revised_for_AKE_2006.pdf</a> )	Taken into account - comment is obsolete as text has been deleted due to space restrictions

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13499	7	39	30	40	2	Text : "Finally, if substantial GHG emissions reductions are required, some of the most cost effective current solutions for system balancing (e.g., relying upon flexible but GHG emitting fossil plant) may no longer be acceptable, requiring the application of currently more costly options." In developed countries with a gas grid, the backup, balancing electricity generation plant that currently burn gaseous fossil fuels could be converted to burn increasing levels of carbon neutral gas fuels - Renewable Gas - mixtures of gas feedstocks, and by-products from the reactions of different thermochemical, catalytic and electrochemical processing of biomass and Renewable Hydrogen - either fed into the gas grid or produced locally to a power plant. However, there would need to be explicit planning for such a fuel change - including making sure that all new gas plant is flexible to a range of fuels.	Rejected - space constraints do not allow to go into the details here.
6242	7	4	5			picture seems pretty much realistic with perspective on the energy demand in developing countries but does not argue on the challenges to provide energy with relativ low energy density in more industrialized countries.	Rejected - comment seems to be misplaced. It is not clear what the reviewer means. Please clarify.
4447	7	40	1	40	4	The reader may be reminded here that large-scale conventional powerplants have lifetimes on the order of 30-40 years which locks the system into a particular operation.	Taken into account - comment is obsolete as text has been deleted due to space restrictions
12548	7	40	10			A recent useful paper on resource adequacy metrics is: John Fazio, 2011. A Probabilistic Method to Assess Power Supply Adequacy for the Pacific Northwest. Northwest Power and Conservation Council. <a href="http://www.nwcouncil.org/energy/resource/Adequacy%20Standard%20Background%20(2008-07a).pdf">http://www.nwcouncil.org/energy/resource/Adequacy%20Standard%20Background%20(2008-07a).pdf</a>	Rejected - not a journal paper.
2837	7	40	10	40	19	It seems very odd to discuss theoretical constructs like capacity credits in terms of "value" and not economic incentives like capacity payments and obligations.	Rejected - specific payments and obligations are a regulatory/institutional layer on top of a physical/economic system. The current approach focuses on the latter rather than region specific institutional arrangements
18073	7	40	13	40	13	replace "with" by "and". The distinction is important as a high fuel supply is not in itself an assurance of reliability.	Accepted - but a different phrasing adopted.
6451	7	40	15	40	16	This statement is also supported by modelling reported by Mason et. al. (2011)	Accepted - Mason ref added to Zotero and cited
9996	7	40	16	40	19	This part should explain that 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. This information is described in (DeCarolis, 2006, page 395 and 403).  <Reference> [1] J.F. DeCarolis and D.W. Keith (2006). The economics of large-scale wind power in a carbon constrained world, Energy Policy 34	Rejected - costs are addressed in 7.8.1.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16825	7	40	23		26	We may have a language issue -- a capacity credit of a coal plant would not be decreased per se, rather the nameplate capacity would decrease -- if the plant operated in a capacity market then yes its capacity credit would then decline. However, it is uncertain how much CCS will be used as coal retrofits vs. being designed as part of new plants. It is not broadly accepted as far as I know that the parasitic losses from CCS can be reduced during peak loads -- if this were so, why would not operators reduce these losses all the time?	Rejected - Since emissions go up during the time that parasitic losses are reduced, the plant operator would only want to reduce the parasitic losses during critical peak times if operating under a carbon constraint. So the plant would not operate with the reduced parasitic losses all of the time. This issue appears to primarily apply to retrofits since new plants would probably be designed to a nameplate capacity specification that already accounts for the parasitic losses.
4448	7	40	27	40	28	Is line 27-28 a repetition of line 15-16?	Taken into account - comment is obsolete as text has been deleted due to space restrictions
4449	7	40	28	40	31	These costs should be quantified. Specifically, how does the cost of energy storage compare with expanding generating capacity and associated fuel costs?	Rejected - costs are addressed in 7.8.1.
17810	7	40	33			After generation at the power station, electricity is transmitted via high-voltage power cables that are supported overhead, or laid underground, and these transmission lines run between substations. In this second stage, the major occupational hazards are electrical in nature, for example electrocutions. The third stage – distribution – connects the transmission system to the customer's equipment, and as in the second stage the main occupational hazards are again electrical (Fox 1998). Compared with the health impacts of the generation stage, there are few non-occupational exposures associated with the transmission and distribution stages of the supply chain. One area that has received particular focus over the past thirty years is the concern over exposure to electromagnetic fields (EMF). The World Health Organization's International EMF Project recently completed a thorough review of all health effects associated with exposure from the extremely low frequency electric and magnetic fields emitted from electric power lines (See: WHO, 2007 at <a href="http://www.who.int/peh-emf/publications/ELF%20EHC%20No238%20full.pdf">http://www.who.int/peh-emf/publications/ELF%20EHC%20No238%20full.pdf</a> ). This chapter mainly provides a summary of the conclusions of this review.	Rejected - space constraints do not allow to go into the details here.
16824	7	40	4			Suggest adding sentence: Within this context, it is helpful to note that the most economically efficient determination of what resources to deploy and when is helped via a CO2 emissions price rather than via mandates to meet certain levels for favored technologies.	Rejected, Point is valid, but it seems to make sense in a policy section rather than this chapter
6699	7	40	43	40	45	It should be noticed that location of nuclear plant is determined by ground conditions and presence of coolant, rather than public health and acceptance.	Accepted - covered by change (see above comment)
9474	7	40	43	40	45	Although location requirements of a nuclear plant may differ according to countries and areas, it should be added that stable bedrock and a lot of cooling water are basic requirements.	Accepted, Change to indicate that cooling and site conditions are major considerations
11768	7	40	43	40	45	Delete [health and safety]. They are too strange for reasons.	Accepted - the text has been changed to public perceptions of H&S
9595	7	40	43	40	45	Please, replace 'reasons of health, safety and public acceptability' with 'a result of site evaluation with regard to safety for the public in case of postulated accidents'.	Reject - see previous comment.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10659	7	40	43	40	45	Delete health and safety. Concern on health and safety are included in public acceptability. Nuclear plants are located at some distance from the load centre mainly because it needs a lot of water for cooling and land cost is cheaper in Japan.	Accepted and re-phrased.
9997	7	40	43	40	45	This part should be deleted completely. In the survey described in (Jablon, 1991), it was reported that any general 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 to  <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: <a href="http://jama.jamanetwork.com/article.aspx?articleid=385351">http://jama.jamanetwork.com/article.aspx?articleid=385351</a>	Rejected but note that text has been revised to make it consistent with other comments.
18075	7	40	44	40	44	add "access to water" after "health, safety"	Accepted - change made
15491	7	40	5	40	31	Resource adequacy - Quote and give figures on Geothermal energy for electricity production with a special attention to the Hot dry rock on-going projects with regards to the impressive potential for this technology to serve on a base load	Rejected - rearranged text and ref to SRREN obviates the need for this.
11937	7	40	5			This section can be incorporated with earlier discussions on resources.	Reject - resources have a different meaning here and there.
11938	7	40	32			This section should be included in earlier T&D discussion, reducing length of document	Reject - these are two separate topics.
18074	7	40	33	40	44	There is an unfortunate and misleading bias in the paragraph. Attempting to address additional transmission needs for the different technologies separately makes sense. The section states that renewables "will often" (line 37); CCS "may" (line 40); and nuclear "may" (line 43) require additional transmission. This is not generally. Most wind energy has been connected to the existing infrastructure (in areas with high penetrations, new lines are needed). The same is true for PV and other RE technologies. Offshore RE technologies, obviously requires new infrastructure, but the term "will often" is misleading. Especially so, when the term "may" is used to describe transmission needs of nuclear (which most often needs new infrastructure due to the scale) and CCS (which would certainly need need least carbon transport infrastructure, as well as electricity in many cases. Gas also often requires additional gas and/or electricity infrastructure. Delete the paragraph and address it without forcing a distinction between (many different) renewables, Nuclear and CCS.	Taken into account - text revised to be more balanced.
5139	7	40	45	41	11	The section should perhaps also include other examples. Recently, a publication " Canada: winning as a sustainable energy superpower" published by the Canadian Academy of Engineering (CAE) Energy pathways Task force ISBN 978-0-9730830-9-5, 2012, <a href="http://www.acad-eng-gen.ca">www.acad-eng-gen.ca</a> , identifies one of the few big national projects vision for a high voltage Pan-Canadian transmission and interconnection scenario for enabling low-GHG electricity while replacing high-GHG electricity generation in many parts of the country.	Taken into account - comment is obsolete as text has been deleted due to space restrictions
18076	7	41	1	41	2	I doubt this is generally true, especially given that many renewables can be applied decentrally. Maintaining this sentence would, at the very least, be substantiated with a credible reference.	Taken into account - a paragraph on distributed generation is added emphasizing that they may show lower demand for an extension of the grid, although this changes if surplus energy is to be transported to higher voltage levels.
10543	7	41	1			Add ..."additional" transmission....	Accepted - text revised.

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10545	7	41	13	41	20	Move to 7.2	Rejected. This is very small description of fuel balance for district heat. It often neglected in many global energy studies. So, many unfamiliar with this sector. That this the reason to keep this text here.
10546	7	41	15			...own use, "which is around XEJ, excluding traditional biomass. Could check these data with IEA Renewable Energy heating and Cooling 2008 report. Are discrepancies.	This is from IEA energy balance (see table 7.1. for details.
11859	7	41	31	41	37	This paragraph is quite confusing and doesn't really offer specific new concepts other than listing potential future technologies. Perhaps it could be shortened?	Accepted - content of the text has been improved.
3788	7	41	32	41	32	Check "cite".	Accepted text revised.
9998	7	41	34	41	36	The potential future technology development should include "heat pump technology" because heat pump is a representative of high efficient water heater. In addition, this part should refer to some examples that high efficient system of heat pump using river water is developed and used.	Agree. But there is relatively small room for this technology to work in district heating systems.
10547	7	41	37			needs a reference	Agreed. Provided.
11860	7	41	39	42	4	Gasoline pipelines and ethanol are not compatible, nor can biodiesel be transported in diesel pipelines if those pipelines carry jet fuel (as is typical in U.S.). In the U.S., ethanol is transported by rail and truck rather than pipeline due to ethanol's hydrophylic properties. This means that ethanol (and biodiesel in some cases) is transported much less efficiently than conventional fuels.	Accepted. Text has been added to limit supply of liquid fuels to the retail end of the distribution chain.
10549	7	41	39	41	43	Repetitive. Suggest delete	Rejected - necessary to provide some context for the following discussion.
10544	7	41	8			Add ..."numerous" small.....	Rejected - numerous is not necessary for being decentral.
18512	7	41				This section is focused strictly on ee improvements. Are there any challenges to fuel switching? E.g. incorporating more RE into district heating systems? Please incorporate mention of this aspect as well.	Taken into account in drafting the SOD.
10548	7	41				Cooling networks not discussed - though is in title	Agreed. Text on cooling systems added.
16123	7	41				The link of alternate gas injection, be it biogas, recombined methane, or hydrogen, is not done with the added flexibility of the links between regions and with storage, possibly an important feature in a 100% renewable system. Overall with section 7.6.3, it leaves the impression that only electrical links will bring flexibility to the power systems.	Accepted: Text has been added to indicate greater flexibility to RE sector via storage.
11939	7	41	38			Combine with 7.5.1 and shorten	Reject: The focus of the current section differs considerably from that of 7.5.1.
7737	7	42	1	42	4	What about GHG emissions reduction opportunities throughout fossil fuels production chains, such as in refineries, for instance?	Taken into account: Industrial processes are largely discussed in Chapter 10, although discussion on refineries is limited. Given the current focus of 7.6.3, the introductory text has ben altered to differentiate between extraction and processing of fossil fuels.
2785	7	42	14	42	22	Personally I am very skeptical of biomethane replacing substantial quantities of natural gas. I think the anticipated scale of such substitution should be mentioned in the paragraph	Taken into account. Data from SRREN has been added.

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10550	7	42	16			Could add more up to date SRREN ref from Ch 8 - Sims et al, 2011	Taken into account: SREEN reference has been added.
12602	7	42	17			UK also injects biomethane into the grid - <a href="http://www.ngvaeurope.eu/uk-becomes-eighth-european-country-to-inject-biomethane-into-the-gas-grid">http://www.ngvaeurope.eu/uk-becomes-eighth-european-country-to-inject-biomethane-into-the-gas-grid</a>	Taken into account: Text has been revised to be more general (page 42 line 13).
5140	7	42	23		34	It seems the entire paragraph is trying to discuss transport of hydrogen. The first sentence in the paragraph suggesting existing natural gas network could be used for hydrogen transport is questionable considering material hydrogen embrittlement issue.	Taken into account: Text has been revised to clarify limits (page 42 lines 17-20).
3004	7	42	23			I doubt that most of gas pipeline is able to transport H2, as written in the manuscript. This gives the reader a wrong idea. Please note that H2 embrittlement is a major corrosion issue.	Taken into account: Text has been revised to include comment on pipeline failure (and fire and explosion).
16827	7	42	24		26	The suggestion that it would be desirable to produce hydrogen from wind or solar seems speculative -- electrolysis of H2O to produce H2 involves efficiency losses, thus raising the cost of the energy (from an already relatively expensive electricity source). If there is "surplus" renewable energy then it is likely that it has already been deployed over the economically efficient level. The costs of this solution should be examined more closely relative to other alternatives.	Taken into account: Text has been revised to mention drawbacks.
13297	7	42	30	42	33	The Yang and Ogden work makes clear that the flow rate and the distance are important determinants not only of the delivery mode cost, but also of the consequent choice of delivery mode (as the flow rate and distance affect the costs of different delivery modes very differently) - it is worth making this clear, perhaps together with the implication that pipelines are favoured over shorter delivery distances and at high flow rates, while liquid hydrogen delivery is favoured by long delivery distances	Taken into account: Text has been revised to indicate differences due to distance.
4450	7	42	33	42	34	Specify that the 3000 km H2 pipelines is the global figure.	Editorial. Text has been revised (page 42 line 28).
6431	7	42	36	42	36	Does the distinction between CCS and CO2 storage need to be made? Can CCS suffice here?	Accepted: The beginning of this sentence can be shortened to "Options for CO2 storage are presented in ..."
9507	7	42	39	43	2	Evidences of these texts are not enough, one paper only, and contains too optimistic aspirations. Texts should be deleted.	Should be 7.6.4. Rejected - it is admissible to present the results even if this is only from one paper as long as others are not contradicting. Please provide publications which support deviating views.
6428	7	42	5	42	5	remove "around the globe" and change to "Over 100 countries transport..."	Editorial: Text has been revised.
17369	7	42	5	42	6	In more than 100 countries... pipeline networks are estimated to have...	Editorial: Text has been revised.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13500	7	42	8	42	30	Text : "...low pressure networks which distribute gas for power generation, industry and domestic use. Because of their ability to carry natural gas substitutes, these networks provide an opportunity to expand production of these gases. Low CO2 emitting natural gas substitutes can be produced from renewable sources such as biomass and waste...Provided the substitute natural gas meets the relevant gas quality standard (European Commission, 2001; IEA Bioenergy, 2006, 2009) there are no technical barriers to the injection of gas substitutes into the existing gas networks (European Commission, 2001). Substitutes are already being injected into natural gas networks. Examples of biomethane gas injection plants based on anaerobic production processes can be found in Canada, Finland, Norway, Sweden, and The Netherlands; Germany has over 50 operational plants injecting biomethane produced from animal waste and agricultural residues (IEA Bioenergy, 2011)...Although limited, the natural gas network also has the potential to transport and distribute hydrogen produced from biomass and fossil fuel sources, or produced to carry surplus energy generated from variable renewable sources such as wind or solar (IEA, 2006; Moriarty and Honnery, 2007; Honnery and Moriarty, 2009). Unless the amounts are small, combining hydrogen with natural gas is likely to mean gas quality standards will not be met (European Commission, 2004; Tabkhi et al., 2008). Large scale injection would require changes to gas appliances so remains a longer term option (Haeseldonckx and D'haeseleer, 2007). Additional factors limiting hydrogen injection relate to the integrity of steel pipelines and end user safety (European Commission 2004)... Biomethane is also being injected in the UK ( IEA Task 37, "UK Experience with Gas Grid injection", John Baldwin, presentation <a href="http://www.iea-biogas.net/_download/publications/workshop/10/Experience_with.pdf">http://www.iea-biogas.net/_download/publications/workshop/10/Experience_with.pdf</a> 15th September 2011). For "transport and distribute hydrogen produced from biomass and fossil fuel sources, or produced to carry surplus energy generated from variable renewable sources", it should be made clear that the text means "carry surplus energy in the form of Renewable Hydrogen generated from variable renewable sources". Although there are limits on the amount of hydrogen that can be carried in the gas grids, owing to the permeability of metals to hydrogen gas, and the implications of changed Wobbe Index on end use appliances, the Dutch are actively supporting 5% hydrogen in Natural Gas - and are testing up to 20% (Kiwa Technology, <a href="http://www.kiwatechnology.com/uploadedFiles/Expert_Centre/Gas_Technology/Publications_and_Patents/Folder_AdvancedEnergySystems_A4_web.pdf">http://www.kiwatechnology.com/uploadedFiles/Expert_Centre/Gas_Technology/Publications_and_Patents/Folder_AdvancedEnergySystems_A4_web.pdf</a> , "PILOT PROJECT ON HYDROGEN INJECTION IN NATURAL GAS ON ISLAND OF AMELAND IN THE NETHERLANDS", <a href="http://www.google.co.uk/url?sa=t&amp;rct=j&amp;q=&amp;esrc=s&amp;source=web&amp;cd=3&amp;cad=rja&amp;ved=0CEQQFjAC&amp;url=http%3A%2F%2Fwww.igu.org%2Ffigrc2011%2Ffigrc-2011-proceedings-and-presentations%2Fposter%2520paper-session%25201%2FP1-34_Mathijs%2520Kippers.pdf%2Fdownload%2Ffile&amp;ei=DDxTUImWaaLB0gWZiYBQ&amp;usg=AFQjCNF6n-NeZ8UN-OEnk7CFQYso-20c2w">http://www.google.co.uk/url?sa=t&amp;rct=j&amp;q=&amp;esrc=s&amp;source=web&amp;cd=3&amp;cad=rja&amp;ved=0CEQQFjAC&amp;url=http%3A%2F%2Fwww.igu.org%2Ffigrc2011%2Ffigrc-2011-proceedings-and-presentations%2Fposter%2520paper-session%25201%2FP1-34_Mathijs%2520Kippers.pdf%2Fdownload%2Ffile&amp;ei=DDxTUImWaaLB0gWZiYBQ&amp;usg=AFQjCNF6n-NeZ8UN-OEnk7CFQYso-20c2w</a> ). In the UK, National Grid, Royal Dutch Shell, ITM Power and Kiwa are about to start testing hydrogen injection into the gas grid ( <a href="http://www.itm-power.com/project/gridgas/">http://www.itm-power.com/project/gridgas/</a> ). The upgrade of the low pressure gas grid in the UK - moving from old metal pipe to plastic pipe, is perhaps highly advantageous for the inclusion of hydrogen in the network. Even if the proportion of hydrogen in the gas grid cannot be higher than around 5%, Renewable Hydrogen would be a very valuable gas stream - it could be methanated with carbon rich flue gases from industrial furnaces, or even from power plants, to provide Renewable Methane for gas grid injection. This could even create carbon credits, if carbon dioxide is prevented from becoming emissions by being recycled into Renewable Gas. It might also be possible to use carbon dioxide to balance the burn profile (discuss this in 7.5.5. It will make more sense to the reader	Taken into account: Text has been revised to give greater clarity (entire section).
11940	7	42	35			Discuss this in 7.5.5. It will make more sense to the reader	Noted. The CLAs made a decision to organize the chapter in this manner. The chapter discusses all relevant aspects of CCS (given space constraints) but because it is broken up and scattered it leads to many comments like this.

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13501	7	42	36	42	38	Text : "Options for CCS and CO2 storage are presented in 7.5.5, the focus here is the infrastructure required for CO2 transport. The recent CO2 transport literature addresses the scale of the required CO2 pipeline network and potential ways to optimize these (largely) yet-to-be-built pipeline networks." It may turn out to be unnecessary to construct CO2 transport pipeline infrastructure if carbon dioxide gas is no longer regarded as waste emissions that requires pumping (to the coast) and burying undersea/underground. The various Renewable Gas processes could recycle carbon dioxide. In fact, it may be more valuable to reuse carbon dioxide than permanently sequester it. The important thing is that initial carbon dioxide production is balanced so that net emissions (after all recycling and capture) to the atmosphere from the ground (fossil fuels) are minimised.	Reject: not supported by the broad body of peer reviewed literature. There is no robust literature that would say that "using" CO2 in this manner and on this scale would be feasible.
3400	7	43	13		19	Excess of references for simple ideas.	Noted: No change to text needed.
7738	7	43	13	43	16	What about the difficulties in obtaining environmental licenses for projects like this in other parts of the globe and the difficulty in assuring the safety os storage?	Rejected. Not supported by the peer reviewed literature. There is no technical literature that can be drawn upon to substantiate a broad and sweeping point like this. At this point in time the comment from the reviewer is conjecture. There is no factual data set that one could draw upon to demonstrate this. I also think given the space constraints this is not one of the most important things that needs to be said.
9508	7	43	13	43	18	"lowest-cost transport option" is not clear the cost level, and cause the misunderstanding of easy installation. This text should be deleted.	Rejected. The text and the supporting references clearly make the required point here. Leave text as is.
10551	7	43	13			Change "storage" to CCS. Also needs a comment about energy inputs for CCS	Rejected. It is not clear what the commenter is referring to here and therefore there is no way to assess the degree to which the text should or should not be modified.
7739	7	43	18	43	19	It seems that the sentence is incomplete when it says that "International institutions and would..."	Accepted - text revised.
16828	7	43	2			Suggest addition of following after "evolve." "Analysis suggest the additional CO2 price required to incentivize the construction of an extensive pipeline system could range from \$10 to \$15/ton CO2." See: <a href="http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17389.pdf">http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17389.pdf</a>	Noted. The CLAs made a decision to organize the chapter in this manner. The chapter discusses all relevant aspects of CCS (given space constraints) but because it is broken up and scattered it leads to many comments like this.
13298	7	43	22	43	29	This paragraph emphasises the impacts of climate change in terms of raising electricity demand for cooling, but fails to mention that it could reduce energy demand for heating in many countries - it could do with more balance	Accepted. Increase of cooling demand and decrease of heating demand are mentioned with more balance.
16829	7	43	25		33	I find these sentences unclear -- what are you trying to say?	Accepted. Rephrased.
14545	7	43	34	43	34	change 'whether' to 'weather'. Sentence could be reworded	Editorial. changed
11861	7	43	36	43	39	Suggest deleting this paragraph. This repeats earlier assertions.	Accepted. Deleted.

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18077	7	43	36	43	36	"grid" instead of "grip"	Editorial. The sentence is deleted.
6190	7	43	36	43	36	"grip" should be "grid"	Editorial. The sentence is deleted.
6441	7	43	36	43	36	Spelling error: grid (not 'grip')	Editorial. The sentence is deleted.
16830	7	43	38			Suggest you insert after "inflexible" the following: "i.e., peaks will become larger relative to normal demand levels"	Rejected - sentence altered such that unclear text has now been eliminated.
13299	7	43	40	43	42	It may be worth adding water desalination as a further example of increased energy demand as a response to climate change	Accepted. Sentence on water desalination is added.
9230	7	43	18	43	18	the world "missing": international institution and WHAT? would be needed----	Accepted - text revised.
3158	7	43	1			Section 7.7 doesn't say much. I suggest delete and ask the adaptation people (WG2? or perhaps other chapters in WG3, such as chapter 15) to address.	Rejected. It is important to focus on the key climate change impacts on energy demand, as a lead-in to the next bit of text on supply side impacts. Moreover, the IPCC agreed to include this overall subsection in each sectoral chapter, with appropriate links to the WGII report.
6921	7	43	29	43	33	Please provide a more specific reference to WGII AR5.	Accepted. Specified: AR5 WGII 8.3.3 and 10.2
12605	7	44				I will send through a short document I wrote on biofuels and how they are effected by climate change, and the same for hydro. It might be useful.	Rejected - documents not received by authors, and not appropriate to include additional citations within the current IPCC quotation that is the primary way in which we convey the possible impacts on RE technologies.
14544	7	44	14	44	14	Add 'Angeles et al., 2010' to the references: Moises Angeles, J. E. Gonzalez, D. J. Erickson, III, and J. Hernandez-Figueroa, The impacts of climate changes in the renewable energy resources in the Caribbean region ASME J. of Solar Energy Engineering, August 2010, 132, 031009 (13 pages), doi:10.1115/1.4001475	Rejected - this is a very short section and we simply do not have the space to add many more references. We have largely tried to cite meta-studies that themselves contain many underlying references for more detail.
6191	7	44	16	44	29	There's no need for such a long self quote; summarize the important conclusions and move on.	Rejected - this self-quote is in fact about the shortest text that one can write to summarize the conclusions of the SRREN
12546	7	44	26			After "countries," add – "At regional scales, climate change will shift hydrographs and potentially decrease total annual output." Il-Won Jung, Heejun Chang, 2011. Assessment of future runoff trends under multiple climate change scenarios in the Willamette River Basin, Oregon, USA. Hydrological Processes, Volume 25, Issue 2, pp. 258-277, DOI: 10.1002/hyp.7842	Rejected - Cannot easily insert text within a quotation, and space constraints for this section are severe. Already noted that country and regional impacts are different than global. Don't want to get into individual regional studies here, as there are many.

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5141	7	44	30		33	If we are thinking about a time scale of more than 25 years for climate change impact on the local wind and solar resources, then the statement "reusing wind turbines, solar panel, etc. at different project sites" is questionable considering typical design life of these components are less than 25 years!	Accepted - There is no reference to reusing specific wind turbines at different sites. Here is the text: "The limited lifetime and portability of some RE technologies, such as wind turbines, solar panels, or bioenergy facilities, may mean that these technologies are more adaptable to such changes; a decline in resource potential in one area could lead to a shifting in the location of projects using these technologies over time to areas where the resource potential has not degraded." We have sought to clarify the text further, however.
12591	7	44	30			I think this statement is an oversimplification which ignores the infrastructural issues. For example, a wind farm will require the transmission and distribution grid to be extended, and improved. Additionally, local substations may be improved, or new ones built. New systems will, ultimately replace old systems as they become obsolete	Accepted - some additional text added
18078	7	44	37	44	38	EWEA has researched this (without having peer reviewed literature on the matter): offshore wind turbine standards and design criteria are already taking into account some CC related extreme conditions, such as rising water levels, gusts of wind, etc...	Rejected - noted, but without a peer reviewed citation we will not incorporate; moreover, we would need to dig up similar information for other offshore infrastructure
17370	7	44	39			(D Arent and Tol, Forthcoming; Karl et al., 2009; S.C. Pryor and Barthelmie, 2010; R. Vautard et al., 2010; Wiser et al., 2011; World Bank, 2011) (S.C. Pryor and R.J. Barthelmie (2010): Climate change impacts on wind energy: A review. Renewable and Sustainable Energy Reviews 14 (2010), pp 430-437.) (R. Vautard et al. (2010): Northern hemisphere stilling partly attributed to an increase in surface roughness. Nature Geoscience Letters, 17 October 2010).	Rejected - The Prior study is included by reference in the Wiser et al meta-study. There are numerous potential studies that could be added, but we need to focus primarily on meta-assessments of the literature
12547	7	44	40			A useful recent reference: S. Rose, P. Jaramillo, M.J. Small, I. Grossmann, J. Apt, 2012. Quantifying the hurricane risk to offshore wind turbines. Proc Natl Acad Sci U S A. 109(9):3247-52.	Accepted
15466	7	44	42	44	45	Although the issue of cable sag in the transmission lines is discussed in section 7.5.2, there is no mention direct mention of how climate change will affect its performance. Specifically, "At the transmission level, thermal expansion of transmission and distribution power lines causes line sag, decreasing the amount of power that can be securely transported through lines." <a href="http://www.dis.anl.gov/news/WECC_ClimateChange.html">http://www.dis.anl.gov/news/WECC_ClimateChange.html</a>	Accepted - have addressed this peripherally. We may not be very specific, however, given space constraints
12604	7	44	44			Worth giving the example of how the drought in Australia has caused issues with a lack of cooling water for coal fired power plants	Rejected - We already noted that power generation facilities may experience performance problems from lack of cooling water. We do not have space to add a specific example.

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5952	7	44	46	47		Objectivity: Nuclear facilities are designed to accommodate extreme weather events. Their resilience is being enhanced following safety reviews triggered by the Fukushima (geological) incident.	Noted - text eliminated
17371	7	44	46	45	3	In countries like France, measures have been taken to protect the nuclear facilities against high ambient temperatures during heat waves. It is expected, that there will be no need for further modifications due to the large margins that have been accounted for in the design changes. No special measures have been taken in France to protect the nuclear power plants against higher wind speeds and more frequent and more powerful lightnings. Only measures to protect the grids against higher wind speeds (storms) are needed. Also, higher ambient temperatures related to extreme weather do not pose a risk for nuclear power plants at river sites in France. Proactive water resource management is mandatory in the EU. An adaptation program is ongoing to preserve river sites in France during the lifetime of the nuclear power plants. For other world regions, adaptation strategies to extreme weather events may be necessary, including, but not limited to, infrastructure relocation and reinforcement, cooling facility retrofit, and proactive water resource management (D Arent and Tol, Forthcoming; Rademaekers et al., 2011; Rübhelke and Vögele, 2011). (K. Rademaekers et al. (2011): Investment needs for future adaptation measures for EU nuclear power plants and other energy generation technologies due to effects of climate change - Final report. ECORYS Nederland BV, Nuclear Research & consultancy Group (NRG), Energy research Centre of the Netherlands (ECN), 2011.	Rejected - all very good points, but section is severely space limited, and this additional detail simply cannot be added (if this detail were added, a lot more detail would also be needed). It is more appropriate for the WG2 report to go into this level of detail. Also need to focus on peer reviewed literature
17372	7	44	46	45	3	<a href="http://ec.europa.eu/energy/nuclear/studies/doc/2011_03_eur24769-en.pdf">http://ec.europa.eu/energy/nuclear/studies/doc/2011_03_eur24769-en.pdf</a>	Rejected - all very good point, but section is severely space limited, and this additional detail simply cannot be added (if this detail were added, a lot more detail would also be needed). It is more appropriate for the WG2 report to go into this level of detail. Also need to focus on peer reviewed literature
10552	7	44	7			Change to ....impact of climate change on transport, including shipping and aviation, while....	Accepted
18513	7	44				Please also make use of the discussions in the IPCC SRREN on cc impacts on RE supply. This is covered in a dedicated section of each of the technology chapters.	Rejected - we already cite the summary for policymakers. Knowledgeable readers will discern that the source for the SPM are the underlying chapters of the SRREN. No need to spent a line of text on this.
11941	7	44	1			Everything in here should be put into the scetions where the particular technology os discussed in 7.5.	Rejected - basic structure of chapter determined by IPCC management, but by LAs

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4782	7	44	30	44	35	I don't agree with this statement: "The non portability and longer lifetimes of dams used for hydropower may mean that these facilities are less adaptable to such changes.". It is true that hydropower has a long lifetime, but it's the first time I heard such a statement that long lifetime is a bad point ... the world need long term vision for curbing climate change, and a 15 year technology is maybe not enough ... ! It is a real advantage to have those assets, as they could provide storage facility (both electricity and water), and regarding the water-energy (-and food) nexus, hydropower will thus play a key role for both mitigation and adaptation to climate change. Could the paper referred as (Roberto Schaeffer et al., 2012) be circulated in order to understand this statement? otherwise please remove the sentence. Furthermore the impact on climate change on hydropower is expected to be globally positive (but with differences from regions).	Accepted -Certainly the longer lifetime of hydropower is a positive in many respects, but with respect to the impacts of climate change / changes in precipitation patterns, the long lifetime is a downside in terms of the adaptability of the facilities themselves. We have, however, made changes to the text noting the possible climate adaptation benefits of long-lived dams from the standpoint of water and energy storage.
4820	7	45	11	47	14	Most of the text in this section could be summarised in a table	Accepted. A diagram has been introduced.
18214	7	45	12		16	Delete: Significant opportunities exist to mitigate greenhouse gas emissions and other climate forcing within the energy sector. These opportunities include efficiency gains in the entire supply chain, reduction of methane and black carbon emissions, and albedo and soil carbon management; the most significant opportunity, however, is a shift in energy supply away from high-carbon energy sources, particularly coal. Comment: It certainly is a great opportunity, however, another great opportunity seen in formal education of the world population for sustainable development and rational consumption, which would impact on the reduction of energy demand and thus the decrease in supply this. Alternative paragraph: Significant opportunities exist to mitigate greenhouse gas emissions and other climate forcing within the energy sector. These opportunities include efficiency gains in the entire supply chain, reduction of methane and black carbon emissions, and albedo and soil carbon management;	Rejected. We prefer to remain specific as the current text is. The suggested text does not really say much.
11769	7	45	14	45	16	Energy must be chosen taking into not only enviromnet but also economy and energy security. To avoid the misunderstanding, [prvided the economy and energy security is not taken into account] should be added after this sentence. Refer to No.4.	Rejected. Please note that economic and energy security aspects are taken up in other sections of the chapter (e.g. 7.8.2) and the report.
6460	7	45	14	45	16	A shift in energy supply may include high-efficient usage of coal with CCS. So, the sentence should be changed to, for example; "the most significant opportunity, however, is a shift in energy supply towards low-carbon, such as renewables, fossil fueled power generation with CCS, and nuclear".	Accepted. "Capture and storage of CO2" was added to the list of important opportunities.
9596	7	45	14	45	16	Please, replace high-carbon energy sources with fossil fuel energy sources, and delete particulary coal.	Rejected. Note that coal is a lot more polluting than natural gas, as apparent from the figure in section 7.5.1.
10660	7	45	14	45	16	Add a statement coal can be chosen from the view point of energy security.	Rejected. This section investigates options available for climate mitigation, not energy security.
10554	7	45	14			Delete " and albedo and soil carbon management" which are not energy supply examples.	Rejected - both bioenergy, solar and hydropower systems can affect these variables.

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9370	7	45	14	45	16	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.	Highly efficient coal fired power plants still have too high emissions to be a meaningful contribution to a stringent mitigation target.
16831	7	45	15			Suggest you replace "carbon energy sources, particularly coal" with "emitting fossil fuel technologies to low emitting technologies."	Taken into account. Please note that I have replaced "high carbon" with "unmitigated fossil" energy sources.
5933	7	45	16			Life-cycle assessments of emissions from generation technologies do not significantly alter the assessment	Life cycle aspects are of crucial importance when going to very low emissions, evaluating bioenergy or hydropower systems or looking at building integration.
16832	7	45	18			Suggest adding after "... energy conversion technology." the following: "In systems which rely on carbon prices to incentivize mitigation, it may be necessary to account for or include life cycle emissions as part of the price regime."	Rejected. Thanks for the suggestion, but questions of policy are not addressed in this section and there is no room for this sentence.
10555	7	45	18			Avoid personal pronouns	Accepted. language has been adjusted. I do not in general agree with avoiding agency in science.
10070	7	45	21		34	The methane issue should be more elaborated, with respect to the differen GWPs in different timeframes for the different GHGs . See: The future of Natural Gas, E. Monitz et al, MIT (2011); Shindell et al, Science 326, 716 (2009)	Taken into account. The forcing of CH4 is an important issue and we are aware of the references suggested. However, the issue of metrics is one of overall importance for this report and it should be treated consistently throughout; hence, this is not taken up here. 100 y GWP are used unless otherwise specified.
5953	7	45	21	30		Clarity: A life cycle approach is appliewd to gas generation whereas coal is treated at point of use only e.g. coal bed methane emissions are not considered in the comparison made.	Rejected. No, all data refers to life-cycle emissions.
10556	7	45	21	46	48	Could be better presented as a table.	Accepted. A figure has been inserted.

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9909	7	45	22			"and further review papers have been published since." Please cite them. Examples for systematic reviews are: Burkhardt, J.J., Heath, G. and Cohen, E., 2012. Life Cycle Greenhouse Gas Emissions of Trough and Tower Concentrating Solar Power Electricity Generation. Journal of Industrial Ecology, 16, pp.S93–S109. Dolan, S.L. and Heath, G.A., 2012. Life Cycle Greenhouse Gas Emissions of Utility-Scale Wind Power. Journal of Industrial Ecology, 16, pp.S136–S154. Hsu, D.D. et al., 2012. Life Cycle Greenhouse Gas Emissions of Crystalline Silicon Photovoltaic Electricity Generation. Journal of Industrial Ecology, 16, pp.S122–S135. Kim, H.C., Fthenakis, V., Choi, J.-K. and Turney, D.E., 2012. Life Cycle Greenhouse Gas Emissions of Thin-film Photovoltaic Electricity Generation. Journal of Industrial Ecology, 16, pp.S110–S121. Potsdam-Institut für Klimafolgenforschung, 2012. Renewable energy sources and climate change mitigation special report of the Intergovernmental Panel on Climate Change. New york: Cambridge university press. Warner, E.S. and Heath, G.A., 2012. Life Cycle Greenhouse Gas Emissions of Nuclear Electricity Generation. Journal of Industrial Ecology, 16, pp.S73–S92. Whitaker, M., Heath, G.A., O'Donoghue, P. and Vorum, M., 2012. Life Cycle Greenhouse Gas Emissions of Coal-Fired Electricity Generation. Journal of Industrial Ecology, 16, pp.S53–S72.	Taken into account. Please note that none of the cited articles addresses all the technologies. Rather, they are technology specific. New data including some of these references are cited as appropriate in the discussion of each individual technology further down. I have reviewed all of the cited papers, but prefer to cite original work over review articles when review articles add little to the original work.
18079	7	45	25	45	26	It would be helpful to have the average CO2 emissions for both oil and gas in co2/kWh here. It says that a combined cycle gas is 60% lower than coal. What is relevant is the average of all gas power plants. Provide the figures. The average carbon emissions for the fossil fuel technologies (oil, gas and coal) should be included, to give the reader a feeling of the challenge of reducing the power sector to below 100 gCO2e / kWh by 2050 and eventually zero (line 34)	Taken into account This issue is covered by a figure.
9475	7	45	32	45	34	Suitable sites for renewable energy or CCS are eccentrically-located and installation of them requires great cost. should be added that there are difficulties to make world's average emission factor of electricity to zero.	Agree that aspects of grid integration need to be better addressed. Little research available and little space.
9999	7	45	32	45	34	If "eventually need to go to zero" means 0C target, this part should be deleted completely. There is not such an international agreement to have 0C target. In addition, 1.5 °C target is not realistic and even 2C target is extremely difficult to attain, as described in (Höhne, 2011, conclusion) and (Rogelj, 2011, abstract). These literatures are listed in the No10 line of this table.	Ch. 6 shows that emissions need to go to zero also for a 2 deg. Target. Reference to Ch.6 is now added.
16833	7	45	33		34	Suggest replace "eventually need to go to zero" with "in the longer term may need to incorporate a large share of "negative emissions" (biomass with CCS)" then replace "even lower" with "negative" later in the sentence. Chapter 6 makes case that if some targets are to be achieved it may be necessary to do a large amount of negative emissions via biomass/CCS as part of an overshoot strategy.	Rejected. Too long and complicated sentence. The feasibility of negative emissions is really questionable from a life-cycle perspective and not investigated here.
10072	7	45	35		44	The assumptions on additional primary energy demand for CCS should be listed. According to Singh et al. coal (supercritical BAT and IGCC with 43% and 44% net efficiency compared to 35% world average) has a 74 to 78% reduction and Natural gas (NGCC and partial oxidation have 58% and 56% net efficiency compared to 42% world average) 64 to 73%. This should be made clear in the text.	Accepted. Text revised.

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6799	7	45	35	45	35	There is much discussion about carbon capture and storage in this chapter. It's very important to indicate that harnessing this approach, if it serves practical will likely take decades. A special issue of Science a few years ago talked about large scale use in the mid 2030s. But nuclear and renewable technologies are available today. This time frame issue needs to be discussed. CCS is not a near-term solution, and it is critical that we address carbon emissions immediately.	Taken into account These are issues that should be considered by the scenario analysis. It does not take longer to build a large-scale CCS facility than a nuclear facility - or to implement large transmission projects required to transport renewables to the customer.
6192	7	45	35	46	13	Long prose summaries of numerical data are rarely more effective than a chart. Charts allow for rapid comparisons and easier lookup. Suggest cutting down on these few paragraphs.	Accepted. A diagram has been introduced.
5161	7	45	35	45	35	is this referring to CCS? clarifications needed - "capture plants" are used several places	Taken into account. It says CO2 capture and that sentence is correct. There is a potential to misunderstand the follow on sentence, which has been changed to "When considering emissions of non-CO2 greenhouse gases and those connected to fuel production, capture plant and CO2 transport and storage, the emission reductions obtain from equipping fossil fuel power plants with CCS are on the order of 64-78%."
9655	7	45	38		44	When referring to emissions of 180-200 gCO2e/kwh - it is not clear what this is referring to. Is this additional emissions associated with CCS on a coal plant? If so, please elaborate. The next sentence is also confusing - is this the fuel production chain in Capture plants? CCS is portrayed as being negative - even though it still has a net positive impact in overall emissions from business as usual.	Taken into account - a figure has been introduced to clarify this issue.
10071	7	45	39			1% leakage: is this the leakage rate for the transport of CO2? What is the annual leakage of the storage?	Accepted. The leakage refers to natural gas, and the language has been changed to make this clear.
15444	7	45	4	45	9	It may be worth noting that the interdependences between the energy sector and other sectors can potentially result in adverse sustainability outcomes. For instance, a climate change driven increase in energy costs may favour irrigation techniques that are less energy intensive but are also less efficient in terms of water use, such as flood irrigation. This would tend to counteract recent trends in irrigation practices in many countries (such as Australia) where water use efficiency is being pursued as a climate change adaptation mechanism, noting that any change in irrigator behaviour would be subject to their individual sensitivity to energy costs relative to water scarcity.	Rejected - a good comment, but outside scope of this subsection, in which we focus on the physical impacts of climate change (not financial). Financial impacts and related sustainability issues are better addressed in Section 7.9
3402	7	45	44			It should be obvious that co-processing of a small fraction of sustainable biomass with coal can bring the specific emissions of CCS systems to zero or even negative values (IPCC SR CCS, 2005).	Rejected. We would need a peer-reviewed life-cycle study that demonstrates this. As this depends mostly on the emissions connected with biomass combustion, it is not mentioned here and could potentially be taken up by the biomass section.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5142	7	45	7		8	The water and energy conflicts could also impact bioenergy! Perhaps it should be mentioned.	Accepted - water/energy conflicts impact many energy supply sources. Rather than listing all of them, we instead alter the text to allow for other non-hydro impacts. Bioenergy related impacts from climate change, including from water, are also already noted earlier in this subsection, so a dedicated new mention here is not needed.
13038	7	45	7	45	9	Suggest adding the word "potentially" before the words "impacting hydropower". Regional conflicts exist currently and can be managed to allow for hydropower negotiation. Increased water conflict across borders may indeed occur due to climate change, but asserting that this will impact on hydropower is not a given.	Accepted - text amended accordingly
5160	7	45	7	45	9	(Sentence starting with "Climate change---") - On the other hand - since hydropower is in the nexus of water and energy it may be seen as a mechanism to solve conflicts by providing available water - the statement here seems too one-sided negative. ref SRREN ch 5.10	Accepted - we also note the adaptation benefits of storage hydropower, though not in exactly the way suggested by the comment
10553	7	45	7			Could add after "Chapter 11)." Conversely, energy-smart food can closely link agricultural production and processing with sustainable energy systems (FAO, 2011). Ref is: FAO, 2011. Energy-smart food for people and climate, UN Food and Agricultural Organisation, Rome. 65 pp. <a href="http://www.fao.org/docrep/014/i2454e/i2454e00.pdf">http://www.fao.org/docrep/014/i2454e/i2454e00.pdf</a>	Rejected - Due to severe space constraints, we cannot add more text to this section unless absolutely essential. The food-bioenergy linkages are addressed in chapter 11, so this important issue is not lost, even if not mentioned here.
13502	7	45	7	45	9	Text : "Climate change may also exacerbate water and energy conflicts across sectors and regions, impacting hydropower development (Cisneros and Oki, Forthcoming; D Arent and Tol, Forthcoming; Kumar et al., 2011)." The exploitation of unconventional fossil fuels is also at risk from climate change-stressed water supplies. The production of shale gas and oil from sands are particularly dependent on water. Water and energy conflicts are likely to become more widespread for most thermal (combustion) electricity generation, particularly higher incidence of drought.	Accepted - slight revisions made to reflect this potential impact, though we do not mention the impact specifically as it is better addressed in the WGII report, where space constraints are of less concern.
4783	7	45	7	45	9	The sentence "Climate change may also exacerbate water and energy conflicts across sectors and regions, impacting hydropower development" should be rephrased on a more positive way. Indeed the IPCC/SRREN stated that, as hydropower is at the cross-roads of 2 pillars for the development of a country (energy & water). It is important to note that climate change will have a global positive impact on hydropower (IPCC/SRREN). Furthermore thanks to the storage provided by reservoir hydropower plants, the development of hydropower regarding multi-purpose users (and under a sustainable way) should be part of the solution for both climate change mitigation and adaptation (control extreme events such as flood or drought seasons).	Accepted - we note the adaptation benefits of storage hydropower, though not in exactly the way suggested by the comment

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13059	7	45	10	55	1	On the Costs & Potentials issues it is difficult for the reader to access the bigger picture of the cost & potential information. Each sector has its own approach to costs and potentials, which is appropriate as each sector has its own unique qualities and considerations. Nonetheless, the information that will be most relevant to take-away for policy-makers is overarching cost information that brings these different pieces together. To help policy-makers access this information, it should be important to highlighting market realization, but also the policy aspects of cost (by policy it is meant institutional frameworks and/or market frameworks and/or capacity building arrangements, etc...). In both developing and developed countries policy can have a strong impact on cost. Simply looking across the costs & potentials sections of the sector chapters, the reader could miss this message, although the information on policies and measures is there in the chapter. Therefore it could be important to make sure that these informations are put in perspective appropriately.	Taken into account - during the Vigo lead author meeting a process was initiated that improves the intercomparability between different sector chapters. Although this is still an on going process that will be finalized for the final draft, the current text has been partially improved. Aspects of capacity building are discussed in the policy section (now chapter 7.12).
18542	7	45				There is a lot of good information in this section, but a lot of it repeats and expands on what appears in 7.5. Why not break it into relevant pieces and present this information there? This would help the reader by keeping the discussion of all emission reduction measures in one place.	Rejected - 7.8.1 serves as a summary section on these issues.
6548	7	45	16			Replace "high-carbon energy sources, particularly coal" with e.g. "high-carbon emitting sources, particularly low efficient coal burning technologies without CCS", as what matters is emissions, and the latest high efficient coal burning technology with/without CCS can be an effective option to mitigate CO2 emissions, especially in developing countries.	Taken into account. The text has been changed to "unmitigated fossil fuel based technologies, particularly coal." to indicated the relevance of CCS. CCS has also been added before in the list of mitigation options.
6549	7	45	32		33	Replace "need to be reduced [...] to meet the 2 degrees C mitigation goal" with e.g. "need to be reduced [...] if the 2 degrees C mitigation goal is to be met", as this goal has not been agreed on globally.	Taken into account. Good point. However, the suggested language change does not really have the intended effect. I replace "the" goal with "a" goal, I hope this is ok.
6550	7	45	33		34	Replace "need to go to zero" with e.g. "need to be reduced significantly" in accordance with AR4 WG1 Report Figure 10.21, or give a reference paper.	Taken into account. Reference to Ch.6 was added.
6551	7	45	35		39	Add description for biomass/biogas co-firing, which has potential to reduce effective net life-cycle emissions from thermal power plants even to zero or below zero if adopted in addition to CCS.	Rejected - space constraints do not allow to go into all details here.
13503	7	45	41	45	44	Text : "Measures to increase energy efficiency and reduce fugitive emissions in fuel production and distribution can give further emission reductions, but these gains may be offset by the need to tap lower-quality resources which result in higher fuel-chain emissions (Section 7.5.1)." Arguably, the world is already using lower-quality fossil fuel resources, although they are still mostly classed as "conventional". Even if the fossil fuels are of a reasonable quantity, their increasing inaccessibility and the distribution effort required are reducing the overall energy rate of return, the Energy Returned on (Energy) Invested (EROI/EROEI).	Taken into account. Yes, and this is mentioned in 7.5.1. We found no published studies that provide firm evidence for increasing emissions, but follow the reasoning.
2973	7	46	1			Here and in the text the importance of the subsidies on fossil fuels should be described, emphasizing that in many developing countries renewable power production would be considerably closer to competitiveness if subsidies on fossil fuels would be removed. See: Tobias S. Schmidt, Robin Born and Malte Schneider, 'Assessing the Costs of Photovoltaic and Wind Power in Six Developing Countries', Nature Climate Change, 2 (2012), 548–553 < <a href="http://dx.doi.org/10.1038/nclimate1490">http://dx.doi.org/10.1038/nclimate1490</a> > [accessed 13 August 2012]..	Rejected - the section is about technical aspects. Subsidies are discussed in 7.12.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16834	7	46	1		30	This section has problems -- begin by talking about the high life cycle emissions associated with particular energy sources, primarily from the manufacture of components to deploy these technologies. It then goes on to note however that as the system emits less and less these estimates will not hold -- this would say to me these estimates are extremely flawed. Perhaps better to say something along lines that in mitigation scenarios, where increasing amounts of low emitting technologies are deployed, that the associated life cycle emissions in the manufacture of these technologies continue to decline. In systems which employ a CO2 price, the cost of the technologies will reflect the associated carbon emissions -- these costs will decline then as the overall system is increasingly low emitting.	Taken into account. Text replaced by figure as per earlier comments.
3789	7	46	1	46	13	Extend discussion to include biomass based electricity generation and, eventually, cogeneration	Rejected. Please note that bioenergy is covered in an annex to chapter 11 and there is not sufficient space to take this up here.
2838	7	46	20			Another reference to what scenarios "will" produce without any corrective to note that this outcome is at present unlikely and would require big changes. For the reasons given on p 24-5 and 29 and section 7.10.5, emissions from marginal production of fossil fuels are likely to increase, not decrease, as unconventional sources take an increasing share and we remain locked in to fossil capacity.	This section has changed due to a figure to be added, and the meaning was clarified. I agree that will should be replaced by would
4451	7	46	23	46	26	Studies exist which show how that PV modules perform at better than 90% name plate capacity after 30 years in the field [Dunlop & Halton (2006). The performance of crystalline silicon photovoltaic solar modules after 22 years of continuous outdoor exposure. Progress in Photovoltaics: Research and Applications, 14, 53 – 64.]. This has implications for the current economic lifetime assumption of 20-25 years for PV devices. Moreover, recovering the material from end-of-life PV modules avoids the need to use virgin resources and associated the associated manufacturing energy penalty. PV modules from recycled materials have up to 60% less embodied energy [ (Bombach et al (2005). Recycling of solar cells and modules - recent improvements. Published at the 20th European Photovoltaic Solar Energy Conference and Exhibition.)]	This comment may suggest that not all potential improvements in PV technology are adequately considered in LCA studies, or that the performance is misrepresented. We try to cite good studied, but potential issues with the literature that we cite must be addressed through the open scientific process.
3790	7	46	23	46	30	When discussing the impact of manufacturing processes or as process emission it should be wise to look the impact due the transportation sector with the introduction of electric or hybrid plug-in vehicles.	Rejected. This issue is not part of the scope of Ch.7.
13040	7	46	31	46	31	The phrase "complex issue" needs to be qualified, especially since the values given are in line with the values for solar and nuclear earlier in the same page (lines 3-5)	Noted. The term "complex issue" does not appear in the document.
13041	7	46	31	46	31	The word 'emissions' needs to be changed to 'flux' because water bodies can absorb and degrade carbon as well	Rejected. "Emissions" is used in the SRREN and kept here for consistency. The literature shows clearly that freshwater bodies are net emitters greenhouse gases (Bastviken et al. 2011, Science 331(6013):50), and this is the primary concern for dams. Yes, they can also absorb, but this is not of concern here.
13039	7	46	31	46	48	This topic is a complex subject to summarize but this paragraph fails to do this accurately and scientifically.	The summary has been changed after a careful reading of the more complete literature.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5162	7	46	31	46	48	this paragraph should be checked against the contents of the SRREN ch 5.6.3 - many of the statements are to categorical and lacks references.	Taken into account. SRREN has been revisited, in addition to many publications on this issue. Text revised and references added.
5935	7	46	31			The discussion of emissions from hydropower facilities should reference the work done by IHA/UNESCO <a href="http://www.hydropower.org/iha/development/ghg/index.html">http://www.hydropower.org/iha/development/ghg/index.html</a>	Rejected. This is a reference to a general website with content that shifts with time - not appropriate.
13042	7	46	32	46	32	CO2 is not an issue with regard to hydropower. The UNESCO/IHA GHG Project has identified that CO2 is already likely to be emitted by the water body irrespective of the existence of a reservoir. The 'issue' is the conversion of CO2 to CH4.	Noted. About 0.9 PgC are transported by the rivers to the oceans. An estimated one half to two thirds of this carbon is in the form of organic carbon. In the ocean, organic carbon either is transported to the deep ocean (akin to the biological pump) or oxidized and dissolved. If dams lead to a reduction of the transport of carbon to the oceans and instead release it as CO2 to the atmosphere, this would have a climate impact within the 100 year time horizon. Cole, J. J., Y. T. Prairie, N. F. Caraco, W. H. McDowell, L. J. Tranvik, R. G. Striegl, C. M. Duarte, P. Kortelainen, J. A. Downing, J. J. Middelburg, and J. Melack. 2007. Plumbing the global carbon cycle: Integrating inland waters into the terrestrial carbon budget. <i>Ecosystems</i> 10(1): 171-184; Huang, T. H., Y. H. Fu, P. Y. Pan, and C. T. A. Chen. 2012. Fluvial carbon fluxes in tropical rivers. <i>Current Opinion in Environmental Sustainability</i> 4(2): 162-169
13043	7	46	32	46	32	Emissions of CH4 can be heavily influenced by upstream unrelated anthropogenic sources or activities, e.g., untreated releases of sewage. This has been observed in reservoir and run-of-river projects.	Taken into account. This is an important aspect but unfortunately, we do not have time to cover this here. It would be nice to have more literature on this.
5163	7	46	32	46	32	delete "run-of-the-river plants" or rephrase "and not" (good language?)	Accepted. Expression has been deleted.
13044	7	46	33	46	33	interfere' should be changed to 'influence'	Taken into account. We have replaced "interfere with" with "change"
13045	7	46	33	46	33	The word 'stopping' is incorrect. Reservoirs may influence the pattern of transport, but they do not stop the flow of biomass.	Accepted. This was incorrectly stated and has been modified.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13046	7	46	34	46	35	Accumulation of carbon does not 'slow' anaerobic digestions. This sentence doesn't reflect current scientific knowledge, and furthermore, it doesn't make sense.	Rejected. In this sentence, 'slow' is an adjective, not a verb. We talk about 'slow digestion', not 'to slow digestion.'
13047	7	46	35	46	36	The sentence beginning 'At the same time...' is erroneous. In the case where there are low level outlets, power stations may draw from the low-level anoxic water, which can increase methane exchange with the atmosphere, but this has nothing to do with surface water.	Taken into account. The original sentence was factually correct, but the reviewer points out that in addition to an exchange of gas between the surface water and the atmosphere, hydropower stations can also further emissions from lower depths. The word "surface" has been deleted.
5164	7	46	35	46	35	"---or after decommissioning." When mentioning decommissioning, there is at least a need for a reference . Historically few hydropower reservoirs have been decommissioned due to the very long life time of this technology. The SRREN found only two decommission examples globally and warned they might not be representative (SRREN 5.6.3.1)	Accepted. Reference to decommissioning has been removed also in the interest of space. Please note that the point is that the biomass that accumulates is likely to degrade and that it is a question of whether it degrades to CO2 or CH4. In addition, the question is whether dams lead to reducing the amount of biogenic carbon reaching the ocean, where less of it will return to the atmosphere.
5165	7	46	35	46	35	Sentence saying "--,power stations also affect --": This is too categorical - they do not always do this. Chanudet et. al found very low or no degassing in two reservoirs in Laos even when CH4 was found in the deep layers - (Chanudet V, et al, Gross CO2 and CH4 emissions from the Nam Ngum and Nam Leuk sub-tropical reservoirs in Lao PDR, Sci Total Environ (2011), doi:10.1016/j.scitotenv.2011.09.018).	Rejected. The existence of a single case among many examined (including two in the paper cited) does not contradict this statement. The paper does not prove that there is no effect even in the case of the Nam Ngum reservoir. The paper indicates that there is a likely effect in case of the Nam Leuk reservoir.
13048	7	46	37	46	37	The concept of 'net flux' has been introduced here without any definition. Net flux represents the true impact of a water body which may then be allocated to its various water users, including hydropower among others. This approach has not been applied in the published literature to date but the scientific community recognizes the need to develop a methodology for this.	Taken into account. The sentence has been deleted. The original text included a reference to the only project where the net flux was measured. However, due to space constraints, this issue cannot be elaborated here.
5166	7	46	37	46	37	"--the net flux of GHG." Ad: suggest footnote: "Net emissions are defined by the SRREN as Gross emissions minus pre impoundment emissions minus unrelated anthropogenic sources (SRREN ch 5.6.3.2 page 47 first sentence) An approach to unrelated anthropogenic sources and to the ghg issue could be found in the IEA Annex XII: managing the carbon balance in reservoirs (Draft), and in the IHA Measurement Field Guide	Accepted. At this point, we keep the reference to net emissions. However, this is a problematic term, as reservoirs take up and release GHGs.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17373	7	46	38			can act both as a sink...	Not clear what this comment refers to
13049	7	46	38	46	38	The word 'boreal' should be changed to 'cool' and the word 'significant' should be removed entirely. In the database of the UNESCO/IHA GHG Project, there are no examples of reservoirs that are 'significant' sources of GHG.	Taken into account. Boreal has been removed. The cited reference shows that some projects have significant, even substantial GHG emissions.
3791	7	46	38	46	38	Replace "temperature" by "temperate".	Accepted.
5167	7	46	38	46	39	"in Tropical regions ---"this sentence state that anoxia and ghg emissions allways will happen in the tropical zone this is not so, in Laos an old reservoir was found to be a sink, see: Chanudet V, et al, Gross CO2 and CH4 emissions from the Nam Ngum and Nam Leuk sub-tropical reservoirs in Lao PDR, Sci Total Environ (2011), doi:10.1016/j.scitotenv.2011.09.018	Accepted. The explicit reference to tropical regions has been removed. The text now cites a specific review paper which illustrates the wide range of emissions in tropical reservoirs.
13050	7	46	39	46	39	Regarding 'tropical regions' the UNESCO/IHA GHG Project has recently confirmed that the key influencing parameter on GHG transport and exchanges is temperature. It is an over-simplificaton to allocate performance to any region, tropical or otherwise.	Taken into account. Language changed.
5168	7	46	40	46	40	"--- leads to ---" - should say "can" or "may"(?) lead to - since the anoxia will not allways happen - factors like shape of reservoir basin, removal of forest to secure circulation by wind and how the reservoirs are operated may secure oxygenation. Thi sstatement is not supported by the SRREN - ref is lacking	Accepted. Language changed.
13051	7	46	41	46	41	An older reservoirs' should be removed. GHG uptake can happen regardless of age.	Rejected. No reference is provided supporting this assertion.
5169	7	46	41	46	41	"Without ---": check logic in sentence	Accepted. Language changed.
5170	7	46	42	46	42	"Reported GHG ---" : this i snot correct - the SRREN say that "The majority of lifecycle GHG emission estimates for hydropower cluster between about 4 and 14 g CO2eq/kWh, but under certain scenarios there is the potential for much larger quantities of GHG emissions, as shown by the outliers" (5.6.3.1 page 44) - So the sentence here needs to be changed, it gives the impression that there exist a general range, valid for all HPP reservoirs of 0-150. The high end is definitely not found often (there are more than a million reservoirs globally, only a few have been investigated - it is important to have a correct picture of this issue, esp since it is not completely resolved.)	Accepted. Language changed to make clear that this is emissions that have been reported in the literature.
13052	7	46	43	46	44	The average age of reservoirs in many countries is in excess of 100 years. There are very few examples of decommissioning and it is misleading to reference these as having the highest values of GHG emissions.	Accepted. The sentence has been deleted. Please note that the original sentence referred to one specific study discussed in SRREN and is valid for that study, it was not claimed that this was an important issue everywhere. However, it is an issue that has not been addressed by any work, so any assertion to the contrary cannot be supported based on scientific literature.
5171	7	46	43	46	44	"-- the decomposition from silt after decommissioning, ---" :as mentioned - the SRREN gives a clear caveat here	Accepted. Decommissioning is removed.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13053	7	46	44	46	46	We consider the value estimated by Barros et al (41gCO <sub>2</sub> E/kWh) to be gross emissions that have not been discounted to account for the true net impact of a reservoir and its (multiple) purposes. However, even with this exaggeration of gross emissions this figure confirms that hydropower is among the lowest sources of GHG per unit of energy produced.	Taken into account. This opinion of the reviewer is not supported by the literature, which rather points into the opposite direction, as noted in the revised text.
5172	7	46	44	46	46	"Barros et al.---" the estimates in Barros et al is Gross emissions based on data collection from the literature, ref the definition on Net emissions given in the SRREN (see another comment to this paragraph) - the Gross estimate does not sort out what is due to nature and what is due to the man-made reservoir, and not what is due to unrelated anthropogenic sources (UAS). one should at least stress that Barros et al is a gross estimate --- since both pre-impoundment and UAS should be subtracted the net should be expected to be less than the gross.	Accepted. "Gross" was inserted.
9656	7	46	46		48	How can the range be 0-40g/kwh for the LCA? Surely 0 is not true - there must be emissions from construction materials? A definition of what is included for each of the technologies should be included to make the comparison between them	This is a range provided in SRREN and cited here. It may be that dams indeed are built for other purposes and power generation has close to no impact, or that there is a net uptake of CO <sub>2</sub> in the reservoir. However, only very odd cases would arrive at that.
13054	7	46	46	46	48	The term 'fossil GHGs' is not a commonly used term. We take it this is intended to mean emissions related to construction, but the rate of emissions on line 47-48 do not carry a meaningful unit. I.e., 0-40g/kWh of what? If carbon, it seems extraordinarily high. This is the only reference we've see that indicates construction is a meaningful factor in a life cycle assessment of hydropower.	Taken into account. CO <sub>2</sub> was added. The ranges quoted here are supported by the literature that is cited.
10073	7	46	5			The reported range for nuclear is not correct: According to the given source, the harmonized range is 3.7 to 110g CO <sub>2</sub> /kWh, depending on the type of reactor. The mean values vary between 11 and 18g CO <sub>2</sub> /kWh, and the range between the 25th and the 75th quartile is: as published 5.6 to 53g CO <sub>2</sub> /kWh and harmonized 6.2 to 33g CO <sub>2</sub> /kWh. In addition, it is mentioned that "Depending on conditions (decreasing global uranium market-average ore grade), median life cycle GHG emissions could be 9 to 110 g CO <sub>2</sub> -eq/kWh by 2050."	We meant to report the interquartile range, as we did for the other technologies, and the cited numbers are from SRREN, but it is correct that the numbers from Warner differ slightly. However, they are smaller, not larger as suggested by this review comment.
9231	7	46	38	46	38	Change temperature region by temperate or warm regions	Taken into account
5173	7	47	10	47	10	"--run-of-the-river" - given the comments to the last paragraph on the previous page (page 46) - delete run-of-the-river and leave only Hydropower.	Accepted. "run-of-the-river" replaced by "many cases". See also comment 13055
2839	7	47	16	47	19	This discussion here should point out that levelised costs are not a good basis for comparison between intermittent and inflexible sources (ie most low carbon sources) on the one hand and dispatchable sources on the other, since the value of electricity is time dependent. Bringing the point in as an afterthought in relation to infrastructure four pages later means it can easily be lost.	Taken into account - a description of the shortcomings and caveats of the LCOE concept has been added in the main text after figure 7.10 as well as in the methodical annex.
5955	7	47	17			The LCOE concept applies to electricity, not "energy" per se.	Rejected - some sources (e.g. the SRREN) use LCOE for non electrical energy as well.
6452	7	47	2	47	2	Spelling error: short (not 'sort')	Accepted
3792	7	47	2	47	2	Typo error. Replace "sort-term" by "short-term".	Accepted

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
7740	7	47	21	47	24	The sentence talks about renewable energy and states that related technologies are presented in Figure 7.12, which also presents nuclear, which is not a renewable source of energy. Please, review the text accordingly.	Rejected - the text does not say that only renewables are shown.
18216	7	47	22			Add to text: The levelised costs of many low carbon energy supply technologies have changed considerably since the release of the AR4. Even compared to the data recently published in the IPCC's SRREN (IPCC, 2011a), the decline of LCOE of important renewable energy (RE) technologies has been significant. Figure 7.12 depicts the LCOE evolution of those electricity supply technologies that Bloomberg New Energy Finance has been tracking in the past three years. The decline of LCOE of important renewable energy (RE) technologies has been significant. In the last four years the costs of renewable energy have declined significantly, especially photovoltaic (up 49%) wind (up 17%). CCS technology reduces the efficiency of power plants by 11% and increases costs by 30%. Nuclear plants have become very costly investment, but operating costs are quite low, producing zero emissions.	Rejected - after a short motivation based on renewable energies, the paragraph constrains itself to the introduction of the figure. Details for single technologies are discussed in other paragraphs.
18217	7	47	22			Alternative paragraph: The levelised costs of many low carbon energy supply technologies have changed considerably since the release of the AR4. Even compared to the data recently published in the IPCC's SRREN (IPCC, 2011a), the decline of LCOE of important renewable energy (RE) technologies has been significant. Figure 7.12 depicts the LCOE evolution of those electricity supply technologies that Bloomberg New Energy Finance has been tracking in the past three years. In the last four years the costs of renewable energy have declined significantly, especially photovoltaic (up 49%) wind (up 17%). CCS technology reduces the efficiency of power plants by 11% and increases costs by 30%. Nuclear plants have become very costly investment, but operating costs are quite low, producing zero emissions.	Rejected - after a short motivation based on renewable energies, the paragraph constrains itself to the introduction of the figure. Details for single technologies are discussed in other paragraphs.
5143	7	47	9		11	What's about for the geothermal and ocean energy technologies?	Rejected. Studies are either higher (deep geothermal) or not sufficient (ocean energy.)
13055	7	47	9	47	11	The qualification of only run-of-river hydropower is not supported by text or references anywhere in this section, nor anywhere in the SRREN report. The phrase 'run-of-river' should be removed so that the sentence indicates that wind, solar, nuclear and hdyropower can provide electricity with less than 5% of the lifecycle GHG emissions of coal power. The vast majority of hydropower will fit in this category, not just run-of-river.	Accepted.
13504	7	47	9	47	11	Text : "The literature reviewed in this section shows that a range of technologies can provide electricity with less than 5% of the life-cycle GHG emissions of coal power: wind, solar, nuclear and run-of-the-river hydro power." I would expect that Renewable Gas (the class of emerging gas fuels that includes Renewable Hydrogen made from "spare" wind and solar capacity, refined and upgraded Biogas, and Syngas from such processes as gasification) when properly developed will be in this group also.	Rejected. No literature reference has been provided to support this claim.
4784	7	47	9	47	11	Proposition to replace the sentence "The literature reviewed in this section shows that a range of technologies can provide electricity with less than 5% of the lifecycle GHG emissions of coal power: wind, solar, nuclear and run-of-the-river hydropower" by "The literature reviewed in this section shows that a range of technologies can provide electricity with less than 5% of the lifecycle GHG emissions of coal power: wind, solar, nuclear, run-of-the-river hydropower and some reservoir hydropower". The storage (water & energy) provided by reservoir hydropower will be a key element for climate change issues (mitigation & adaptation).	Accepted. "run-of-the-river" replaced by "many cases". See also comment 13055

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18543	7	47				It would be very helpful to have one summary sub-section that includes a comparison of LCOEs across RE, CCS, nuclear and to the extent possible, infrastructure costs. This would also be a major output of Ch 7 that could feed into the technical summary and SPM.	Rejected - space constraints do not allow for this comparison. In addition, the data ranges are too broad to allow general statements.
4358	7	47	14			As the section title indicates, this section discusses "costs" of mitigation measures. However, a holistic, social-cost analysis of electricity cannot only focus on the average generation costs, but needs to take into account where and where electricity was generated (see my comment on LCOE). Even if a coal plant is "cheaper" as measured in average generation costs than a gas plant, that doesn't mean that it is not socially (and privately) cost-optimal to employ a gas plant (or, indeed, a mix of coal and gas plants). This is mainly due to the different variable-to-fixed cost ratios of technologies, or, in the case of solar/wind power, due to the fluctuating nature of the underlying resource.	Taken into account - a description of the shortcomings and caveats of the LCOE concept has been added in the main text after figure 7.10 as well as in the methodical annex.
4356	7	47	14			LCOE is a misleading metric when comparing dispatchable technologies with fluctuating generators, or when comparing different dispatchable generators with varying variable-to-fixed cost ratios. The reason is that electricity is not an homogenous good over time, that means that its value (private as social) depends on the point of time it is produced. Since different technologies produce at different times (e.g. peakers only at times of high prices), comparing average generation costs is highly misleading. However, trends over time are of utmost importance, of course. I propose to a) highlight this fundamental shortcoming in the text and b) change the figure such that it focuses on development over time rather than cross-technology comparison. Development over time by itself is impressive and interesting enough! See Joskow, Paul (2012): "Comparing the Costs of intermittent and dispatchable electricity generation technologies", American Economic Review 100(3), 238–241.	Taken into account - the caveats concerning the use of LCOE are emphasized by a footnote which refers to the respective discussion of these shortcomings in the Methodological Annex. In addition, caveats that should be observed while interpreting LCOE are mentioned after figure 7.10
4357	7	47	14			References regarding renewables are limited to IPCC, IEA, and Bloomberg NEF; that seems somewhat flawed	Rejected - the cited sources are reliable ones. The reviewer is asked to provide further material that can be considered for inclusion.
4452	7	48		48		This graph needs a label on the x-axis	Taken into account. The units are given in the figure caption.
18215	7	48				Comment: In this figure should include costs program Implementation educational and UREE measures by region. And if not exactly apply to this figure, Similarly it should be mentioned in the text of Chapter 7 the mitigation option climate change through programs formal education from childhood, which contribute to the formation of men and Women more environmentally responsible and less consumerist.	Rejected - the figure only shows technologies cost. The general comment refers to behavioural aspects of consumers, which are to be treated in the chapters on energy demand (e.g., building and transport).
10074	7	48				As LCOE from RES change very fast, a regular update of this figure is encouraged.	Accepted - this is done.
18080	7	48				The figures for nuclear seems very low. In an interview with Daily Telegraph 12/8 2012, EDF 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 <a href="http://www.telegraph.co.uk/finance/newsbysector/energy/9470555/EDF-chief-Vincent-de-Rivazs-nuclear-vision-aims-to-inspire-a-generation.html">http://www.telegraph.co.uk/finance/newsbysector/energy/9470555/EDF-chief-Vincent-de-Rivazs-nuclear-vision-aims-to-inspire-a-generation.html</a>	Taken into account - the cost of nuclear power plants were updated according to the newest available cost data from the BNEF data base. Whereas the highest of these are close to the given specific capital expenditures, the derived LCOE deviate from the ones given in the interview. The LCOE values mentioned in the interview therefor are not considered to be reliable.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
15949	7	48		48		Why not take the cost figures from figure 7.13 for fossil generation with CCS and include them in this figure - it would make for some useful comparisons	Taken into account. Chart is changed.
5174	7	48		48		Small Hydro/Large hydro on the Y-axis : use same wording as the SRREN: Large Scale Hydro or Small Scale Hydro- since nobody actually knows what small or large hydro is (no globally accepted definitions based on MW! SRREN ch 5.3.1 and 5.4.3.4)	Taken into account - a size limit of 10MW is used for small hydro. Text revised.
10557	7	48				This is from a single reference. Better to assess the literature and produce own data and revise text accordingly. Why is nuclear such a small range for example? I don't believe it	Taken into account - additional sources were used to describe the cost of nuclear power plants. The nuclear range now is larger.
9232	7	48		48		To limited the title: Figuer 7.12 Levelised cost in \$/MW.h of electricity for commercially available fossil and nuclear power plants as well asrenewable energy technologies as observedfor the second quarter of 2012 (and for the secondquarter of 2009) The rest of parragraph send to foot page	Accepted - text revised
12329	7	48	1			The figure is interesting. It is, however, unclear how the cost of carbon is taken into consideration. Annex II states that carbon costs are included in LCOE. Does this mean that for coal fired plants the blend include European production with EU ETS pricing? If so, what are the assumptions about EU ETS prices? It would be useful to add a similar figure (or two) that includes carbon pricing for all fossil energy production. The point would be to show that fossil fuel power plants are operating without having to pay for their pollution costs and that, as this changes, their competitive advantage would change quite significantly. We suggest two scenarios; one with a carbon price of \$20 and on at \$100 per tonne CO2.	Taken into account - the cost of carbon has been excluded from the results. There is a still on going process to collect additional literature and data concerning gas and coal fired power plants in the context of the recent changes in the gas markets. The final draft will show bars for coal and gas fired power plants together with sensitivities due to CO2 prices.
3793	7	48	1	48	8	I am surprised with some of the results, in particular biomass gasification. Can you report where there are commercially operating power plants based in this technology?	Taken into account - numbers have been revisited and confirmed by the Bloomberg New Energy Finance database. Please provide material that supports your view in order to check this point once again.
13202	7	48	1			The cost of nuclear nergy in France has recently been estimated by the "Cour des Comptes", the highest financial jurisdiction in France, to 60 \$/MWh, including the post Fukushima safety improvements. This value is significantly below the lower end of the bracket shown in the figure	Taken into account - IEA data now are used for nuclear. The lower end of them (referring to reactors in Korea) is below the number mentioned here. Without additional material the reliability of the cited value (60 \$/MWh) - which is very low for the French design - could not be evaluated.
10558	7	48	14			Could add a sub-heading "Renewable Energy" here and also for "Fossil fuels and CCS" and "Nuclear" below where relevant to aid the reader.	Taken into account - the different figures are merged to become a single one. Subheadings therefore are no longer necessary.
11942	7	48	15			"PV proces fell..." Need reference.	Taken into account - the underlying text has been replaced.
15543	7	48	9		13	Should also mention sensitivity to economic projections.	Accepted - text revised

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2786	7	48	9	48	27	The BNEF references are generally directionally right but they do not take into account country specific costs and factors and so can be quite misleading if applied to a particular situation. The data basically shows that everything but STG and Marine are between \$100 and \$200 / MWh and I would say that is the granularity that you can use generic global data at.	Rejected - BNEF does take into account country specific conditions.
4785	7	48				This figure is very interesting. However it could be interesting to define what is the size limit between small and large hydropower. Please also refer to IRENA, 2012 publication on LCOE with recent values provided. Year of the \$ expressed for LCOE?	Taken into account - a size limit of 10MW is used for small hydro. IRENA, 2012 is cited. The dollars are those in 2010.
10559	7	49	1			A variety of....? Be specific.	Rejected - the diagram shows all of them. Repetition is not feasible due to space constraints. The underlying text has been shorted.
18081	7	49	16	49	16	Delete (if the cost of carbon is reflected in the market). To indicate that onshore wind should be less competitive than e.g. solar thermal or PV is incorrect. In Turkey, New Zealand, Brazil and other places, onshore wind is winning tenders at lower prices than any of the mentioned technologies, as well as gas. In Brazil's 2011 tender wind power contracts were awarded at BRL 100 / MWh (US\$ 50 / MWh).	Taken into account - the questioned text has been deleted.
17374	7	49	17			onshore wind power plants...	Taken into account - comment is obsolete. Text has been deleted.
2787	7	49	17	49	19	The sentence compares the cost of supply of energy and the value of energy consumption which are two different things (say for PV on a rooftop). PV panels on a rooftop rely on the grid and associated systems as much as a remote large-scale power generator and so I believe that the comparison made is erroneous and can be misleading.	Taken into account - the underlying text has been deleted due to space constraints. The comment is obsolete.
9597	7	49	20			Please, add following information as RE is already competitive; Grau[1] reviewed the adjustments of the feed-in tariff for new solar photovoltaics(PV) installations in Germany and developed an analytic model to simulate weekly installations of PV systems≤30kW(35% market share in 2010) based on project profitability and duration. The model shows the need for (i) more frequent tariff reductions (ii) and an appropriate choice of adjustment response parameters. The analysis shows that adjustment schemes with more frequent tariff reductions would have reached development targets in 2011 more effectively. [1]Thilo Grau Responsive adjustment of feed-in tariffs to dynamic PV technology development (2012 ) German Institute for Economic Research (DIW Berlin) Discussion Papers 1189 <a href="http://www.diw.de/documents/publikationen/73/diw_01.c.392871.de/dp1189.pdf">http://www.diw.de/documents/publikationen/73/diw_01.c.392871.de/dp1189.pdf</a>	Rejected - comment is misplaced. The discussion of the feed-in tariff refers to chapter 7.11. Unfortunately, the comment cannot be taken into account there, because it addresses a very special aspect of the feed-in tariff system. These details cannot be discussed due to space restrictions.
17751	7	49	23			replace "fuel" by "plant"	Accepted - text revised.
6800	7	49	23	49	34	Similar comment as before. The costs and efficiency penalties associated with carbon capture and storage make it sound like this is a technology available today. It is well into the future.	Taken into account - The fact that commercial CCS power plants are not yet existing is emphasized.
6193	7	49	23	49	24	"Applied to fossil-fuelled power plants, CCS reduces the fuel efficiency of those plants. Typical efficiency differences projected for 2015 are on the order of 8-11 % points." The 8-11% points is a very misleading way to express changes, as its significance depends greatly on the starting efficiency. This would be better expressed as a change in overall efficiency, e.g., a change from 40% to 36% would be a 10% drop, not 4 percentage points.	Rejected - it is common scientific practice to express absolute changes of % values by %-points.
6453	7	49	23			See also Page et. al. (2009) for energy penalty data and discussion	Rejected - publication cannot be considered without additional information. The provided reference is sufficient.
17752	7	49	24			replace "differences" by "penalty"	Accepted - text revised.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
7741	7	49	3	49	22	This whole paragraph replicates what has already been published in the SRREN. What is the purpose of this? Shouldn't the AR5 provide newer findings?	Taken into account - the purpose of this paragraph is to provide a summary of the cost of renewable energies in comparison to the development of other low carbon technologies. Part of the paragraph therefore has to stay, but its size is reduced.
2840	7	49	3	49	22	The quotation here is selective. One could as easily quote different passages from IPCC 2011a – eg “the current levelized cost of electricity (LCOE) from solar PV is generally still higher than wholesale market prices” (p 380) “Commercial markets are not yet driving marine energy technology development” (p 522) “Though the cost of wind energy has declined significantly since the 1980s, policy measures are currently required to ensure rapid deployment in most regions of the world” (p 583) and so on – to give a completely different impression. The unbalance in the text obscures the important fact that, with some notable exceptions, most renewable sources in most parts of the world are not competitive and require subsidies. If life were otherwise, the problem of decarbonisation would be easier to deal with	Taken into account - text revised.
10560	7	49	5	49	22	Could add there is a cost related to integration but largely unknown for most technologies (Ref SRREN Ch 8)	Rejected - integration costs are discussed in the same section (a couple of lines below).
13505	7	49	20	49	22	Text : "Although the gas prices went down in the last few years in many regions, the increase in capital expenditures and operation and maintenance costs is explaining the raising LCOE of natural gas combined cycle power and coal-fired power plants." For those countries with extensive gas grid and related infrastructure, it will be of benefit to invest in Renewable Gas, to displace carbon in the gas supplies, but also, potentially, to reduce the impact of potentially rising costs of the raw fuel. Lifecycle investment and operations and maintenance will still be necessary, but increasing availability of low carbon gas fuels, at reasonably low costs, should remove the operating risk of choosing to continue with gas-fired electricity generation.	Rejected - comment is misplaced. Power to gas or biogas are discussed in chapter 7.5 and 7.6, respectively.
17203	7	5	1	7	20	The summary does not note the emission reduction potential of the energy sector and sub-sectors within. A useful reference is Luderer L, Pietzcker RC, Kriegler E, Haller M, Bauer N (2012): Asia's Role in Mitigating Climate Change: A Technology and Sector Specific Analysis with ReMIND-R. Energy Economics Special Issue on the Asian Modeling Exercise. Accepted for publication.	Rejected - space constraints do not allow a deep dive here
11844	7	5	1	5	3	The opening sentence is ambiguous - it is not clear what the 45% refers to. Grammatical errors may be the source of some of the ambiguity	Taken into account - text has been deleted. Comment is obsolete.
6243	7	5	1			price, tax and subsidies trends are missing	Rejected- space constraints do not allow for a consideration of these very specific things.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
7475	7	5	1	87	24	<p>I have already submitted my comment on this chapter (upload document 218). However, I don't think my general comments were uploaded. I repeat them here.</p> <p>First some background information. I have had over 40 years experience in renewable energy, especially biomass energy. I have worked in over 50 countries on biomass energy surveys, wood consumption/timber trends studies, renewable energy supply &amp; demand, biomass inventories and the environment. I have lived in Africa and Asia for 17 years.</p> <p>Some of my recent publications, which are pertinent to this chapter, are:</p> <p>Openshaw, K (2010a). Employment generation by biomass energy and its contribution to poverty alleviation in Malawi and other developing countries. Biomass and Bioenergy Journal 34, 2010. Elsevier, Oxford, England UK.</p> <p>Openshaw, K (2010b). Can biomass power development? Gatekeeper Series 144, April 2010. The International Institute for Environment and Development (IIED), London, England UK.</p> <p>Openshaw, K (2011a). Biomass as a benign energy source. Chapter 52 in Encyclopedia of Agrophysics. Eds. J. Glinski, H. Horabik, J. Lipiec. Springer.com/agrophysics. P.O. Box 17, 3300 AA Dordrecht, the Netherlands.</p> <p>Openshaw, K (2011b). Supply of woody biomass, especially in the tropics: is demand outstripping sustainable supply? The International Forestry Review, Vol. 13(4), 2011. Ed. A.J. Pottinger, the Crib, Dinchope, Craven Arms, Shropshire, SY7 9JJ UK. Published by the Commonwealth Forestry Association.</p> <p>Barnes D.F., Priti Kumar, Keith Openshaw (2012). Cleaner hearths, better homes: new stoves for India and the developing world. Oxford University Press. The World Bank. ESMAP (energy sector management assistance programme). ISBN 0-19-807836-6.</p> <p>Openshaw, K (2012). Remote sensing of biomass: principles and applications. Submitted for publication to the second sustainable world forum.</p>	Noted.
7476	7	5	1	87	24	<p>Biomass energy is the only energy form that is treated in two ways, namely 'traditional' and 'modern'. This separation infers that 'traditional' biomass energy is non-sustainable and has to be substituted as quickly as possible for 'modern' biomass and other forms of renewable energy (RE). For example, P. 18 line 14 states that biomass and waste (demand) are growing at 2% per annum including traditional and modern ---. P. 57, line 8. "Providing clean, affordable and reliable modern energy services is also at the heart of development challenges in many developing countries ---". P. 57 line 12 "over 3 billion people are estimated to lack access to modern fuels for heating and cooking ---". P 58 line 6 "The provision of access to clean, efficient, affordable and reliable energy services entails multiple co-benefits ---". Also, footnote 1 on page 9 talks about more comprehensive coverage of energy resources, including non-commercial ones (i.e. traditional ones).</p> <p>Granted unprocessed biomass has a lower energy value per unit weight and is more difficult to control than liquid and gaseous fuels. But charcoal is lumped with fuelwood, residues and dung as traditional. Charcoal is a processed smokeless biomass fuel that has an energy value on par or better than most coals and has never been 'non-commercial'. To denigrate some biomass as traditional, infers that the people using it are handicapped! In my opinion, there should be no distinction with types of biomass as inputs for different end uses.</p>	Rejected - the distinction between traditional and modern biomass is used in many peer-reviewed articles and in energy statistics.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
7477	7	5	1	87	24	Chapter 7 keeps on mentioning energy access to modern fuels. But what it really means is access to electricity, for most people do have access to kerosene for cooking and lighting and many have access to LPG and even natural gas, especially in urban and peri-urban areas. However, for the rural population, if biomass is available within a reasonable collection area, most will use it in preference to fossil fuels. Kerosene is used sparingly for lighting in the absence of electricity and sometimes as a starter fuel for charcoal etc.	See section and references in 7.9.1.2
7479	7	5	1	87	24	Although much fuelwood, residues and dung are collected, some are sold to households, the service sector and industry or grown specifically for industry (wood for tea drying) or industrial residues used for heat and steam (bagasse). Commercial biomass production is an important source of income and employment, especially for rural people. (Openshaw, K 2010a). It is estimated that about 30 million people worldwide are employed (full time) in the growing/managing of trees, and the production, transport and trade of biomass to sell so-called non-commercial energy to households and non-households. This is 26 times larger than that specified on Page 67, lines 6-12 and 2.5 times larger than the forecast for 2030! Rather than encouraging the shift away from 'traditional biomass energy' the chapter should be promoting it, for it is one important way to help poverty alleviation.	The move away is motivated by two concerns: unsustainable harvests and high PM emissions during combustion.
7480	7	5	1	87	24	Throughout the chapter the sustainability of supply of RE is mentioned and Figure 7.9 depicts global technical potentials of RE sources. For biomass the technical potential range is from a minimum of 50 EJ to a maximum of 500 EJ. I don't know how these figures were derived, but the net primary production (NPP) of terrestrial biomass is about 53 GtC/yr, equivalent to about 2000 EJ (Openshaw, K 2011b – citing Melillo et al 1993). The total NPP is approximately 4000 EJ including NPP in oceans and other water bodies). For wood alone, the accessible NPP is an estimated 343 EJ (total 404 EJ) and the current demand for all wood products is an estimated 66 EJ. Thus, much more annual wood yield could be used without making inroads into the tree capital. (Openshaw, K. 2011b). However, P 26, lines 33/34 state "Because the theoretical potential does not take into account energy conversion losses or deployment barriers, the theoretical potential is of relatively little practical use". For biomass energy, I think this statement is wrong. Local people know their resources and if given some simple training (and tools) they could manage them more effectively, especially if they have control over them and have expanded markets. □	Rejected - the bioenergy potential data are based on the IPCC SRREN.
7481	7	5	1	87	24	More will be said about this when discussing the Bioenergy Annex, pages 88 to 96. However, the impression is left here and in Chapter 11 that cutting down trees is reducing the forest capital (deforestation) when most is harvesting, unless land is being cleared for pastoral and arable agriculture. If the annual capture of CO2 by biomass is not used, it reverts back to atmospheric CO2 (the carbon cycle). If you don't use it, you lose it! The use of crop and tree residues and such crops as Panicum sp. (switchgrass) and Miscanthus sp. (silvergrass) as a feedstock for ethanol production, is being promoted as are waste products or crops that do not compete with food crops. But, the breaking down of cellulose to simple sugars is not easy and not very efficient. Page 33 line 8 states that "lignocellulose-based transport fuels (to provide ethanol) are at a pre-commercial stage". However, the thermal breakdown of cellulose to liquid and gaseous products has been practiced for centuries. One of the first building blocks for the organic chemical industry was wood alcohol (methanol) and this can be used as a liquid fuel directly, or turned into petrol (gasoline) or diesel. Likewise, another product of dry distillation is gengas (CO + H2). This can be used to make motor fuels etc. It may be cheaper and more efficient to go this route, rather than the ethanol route for lignocelluloses products. Also, these products can be burnt directly in boilers to produce heat, steam and/or electricity. Moreover, if wood is the feedstock, the ash is a valuable fertilizer, for it has a relatively high content of potassium (K). □	Noted - comment is obsolete as the bioenergy annex has been moved to chapter 11.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
7482	7	5	1	87	24	It was also stated that silvergrass does not require much if any N fertilizer (P 90 line 19). Its average yield is about 14-15 dry t/ha with a rainfall of about 1500 mm. (Energy value 16.6 GJ/t. – 5% ash content). This will require 70-75 kg N/ha to maintain productivity: similarly for switchgrass. Carbon capture and store (CCS) figures prominently in this chapter. Yet the costs are high and technical problems, plus leakage risks have not been solved. About 25% of the generated energy is used to compress and 'purify' the CO2. Pipelines have to be built to suitable storage sites and both have to be monitored for leaks. It may be cheaper to grow (woody) biomass to store an equivalent amount of useful energy. What is more, the annual yield from a managed plantation with an equal representation of all age groups, when fully operational, will give a product that can be used to generate electricity etc. Surely, this is better than burning coal?	Noted - comment is obsolete as the bioenergy annex has been moved to chapter 11.
7850	7	5	1	7	20	This executive summary is a good example how every paragraph includes a reference to the underlying subchapter as well as a statement on the uncertainty in the calibrated IPCC-language.	Noted.
2783	7	5	1	5	7	The beginning of this section is quite garbled and I couldn't quite figure out what the start of the first paragraph was trying to say	Taken into account - text has been deleted. Comment is obsolete.
2938	7	5	1	5	3	"The energy sector...provides only 45 % of energy-related GHG emissions." So where are the other 55% ?	Taken into account - text has been deleted. Comment is obsolete.
3766	7	5	13	5	13	"are not yet sufficient". As written the message states that the policies in effect will be able to curb GHG emissions in the energy sector. Is this the purpose of the sentence?	Taken into account - text has been deleted. Comment is obsolete.
4803	7	5	14	5	14	I am not familiar with 450ppmv CO2eq - could you explain in a footnote for non-experts?	Taken into account - text has been deleted. Comment is obsolete.
18160	7	5	16			By 2050, growth in population, economic activity and energy access is expected to give rise to a 1.6 to 2.5 fold increase in energy use and energy related GHG emissions in business-as-usual scenarios [7.12, high agreement; medium evidence]. Fossil fuel resources are abundant and cost competitive with other energy forms. Since the industrial revolution, fossil fuel combustion released almost 400 Gt C into the atmosphere. Left hydrocarbon reserves alone contain two to four times that amount of carbon.	Noted - the comment repeats the original text. Please clarify on what you are commenting on.
18158	7	5	16		23	Delete: By 2050, growth in population, economic activity and energy access is expected to give rise to a 1.6 to 2.5 fold increase in energy use and energy related GHG emissions in business-as-usual scenarios [7.12, high agreement; medium evidence]. Fossil fuel resources are abundant and cost competitive with other energy forms. Since the industrial revolution, fossil fuel combustion released almost 400 Gt C into the atmosphere. Left hydrocarbon reserves alone contain two to four times that amount of carbon. Therefore, limits or constraints on fossil fuel availability cannot be relied upon to limit global GHG concentrations to levels consistent with the Copenhagen Accord [7.4, high agreement; robust evidence]. Comment: The Bolivarian Republic of Venezuela does not consider the Copenhagen Accord as a legitimate document of the UNFCCC, and bad could be used as official reference.	Taken into account - the reference to the Copenhagen Accord account has been replaced by the Cancun Agreement. The remaining part which has nothing to do with the Accord, however, is not deleted.
18159	7	5	16		23	Alternative paragraph:	Rejected - comment is unclear. Please clarify
4802	7	5	16	5	23	Expected increase in energy use: are these values coming from governments/ academia / both?	Taken into account - text has been deleted. Comment is obsolete.
10042	7	5	16	5	17	According to SRREN Chapter 10.3 there are scenarios which indicate a possibility to increase the energy demand significantly less than 1.6 times. Please more resources	Taken into account - text has been deleted. Comment is obsolete.
4774	7	5	18	5	18	Please add "still" in the sentence. Proposition "Fossil fuel resources are still abundant and ..."	Taken into account - text has been deleted. Comment is obsolete.
12316	7	5	18	5	19	Please consider to add to the sentence : ... other energy forms, as long as their externalities, i.e. GHG emissions, are not included.	Taken into account - text has been deleted. Comment is obsolete.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
11911	7	5	18			fossil fuels are cheaper than most other energy forms. So they are more than "cost competitive"	Taken into account - comment is obsolete. Text has been deleted.
12154	7	5	18	5	18	The sentence "...Fossil fuel resources are abundant..." is too simple considering the relevance of the AR5. I understand that it'll be better to use..."...Fossil fuel resources are abundant, typically located...". Including the term "typically located" is very important because the no uniform distribution in the terrestrial crust is fundamental any context.	Taken into account - text has been deleted. Comment is obsolete.
10486	7	5	19			"has" released	Taken into account - text revised.
3383	7	5	2	5	5	Puzzling and long first sentence. I sign of what is coming. There must be better ways to define the "energy sector" presented in this chapter from the remaining 55% "energy-related GHG emissions" (transport, industry, buildings... treated in the subsequent three chapters?) .	Taken into account - text has been deleted. Comment is obsolete.
2388	7	5	2	5	2	put percentage of energy sector emissions in parantheses in first line	Rejected - comment seems to be misplaced. It is not clear what the reviewer means. Please clarify.
12315	7	5	2	5	5	This sentence is somewhat confusing. Please define what is included in the energy sector. It is also unclear what percentage of emissions are the result of fugitive methane emissions etc. The sentence might benefit from being split into several sentences.	Taken into account. The scope of chapter corresponds to definition of energy industries in the IPCC inventory Guidelines. It is made clear in the introduction
15789	7	5	2	5	5	First sentence is too long	Taken into account - text has been deleted. Comment is obsolete.
9626	7	5	2	5	5	This first sentence is confusing - does the energy sector provide 45% of total global emissions or do the activities listed contribute 45% to energy related emissions? If it is the latter, what contributes the remaining 55% of energy related emissions?	Taken into account - text has been deleted. Comment is obsolete.
13282	7	5	2	5	5	There are two problems with this sentence (the first of the Executive Summary): a) it does not make grammatical sense ("...it provides only part of energy-related GHG emissions in form both fugitive emissions in fuel extraction...") and b) it only makes logical sense that 45% of energy-related emissions are in the energy sector if one understands that the energy sector is not in fact the entire energy system, but specific types of energy use (presumably heat and power generation) - it is essential that the energy sector is defined here for this to make sense	Taken into account - text has been deleted. Comment is obsolete.
6162	7	5	2	5	5	The energy sector is the largest contributor to global GHG emissions, but it provides only part (45%) of energy-related GHG emissions is a confusing sentence. Perhaps rephrase as "Energy extraction, conversion, storage, transmission and distribution processes, collectively comprise the energy sector and is the largest contributor to global GHG emissions."	Taken into account - text has been deleted. Comment is obsolete.
3767	7	5	2	5	2	Check "45% contribution".	Comment is obsolete. Statement has been deleted.
4800	7	5	2	5	5	This first paragraph is not clear for a reader that has not read the rest of the document.	Taken into account - text has been deleted. Comment is obsolete.
5144	7	5	2		5	unclear sentence	Taken into account - text has been deleted. Comment is obsolete.
10483	7	5	2			Suggest reword opening sentences..... contributor to "annual" global GHG emissions. It provides 45% of energy-related GHG emissions in the form of both fugitive methane emissions in fuel extraction and distribution and .... [the word "transportation" can be confusing] BUT does the 45% include Transport? The whole chapter needs to check whether transport is included or not in many statements.	Taken into account - comment is obsolete. Text has been deleted.
2391	7	5	20	5	20	replace word left with word remaining	Taken into account - text revised.
13283	7	5	20	5	20	The word 'Left' is not standard English in this context - suggest 'Remaining'	Taken into account - text revised
5145	7	5	20		21	unclear meaning	Taken into account - text revised

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
11912	7	5	20			"left" is awkward. "Remaining" is the correct word	Taken into account - text revised.
10487	7	5	20			Delete "Left" so becomes "Hydrocarbon reserves contain....."	Taken into account - text revised.
7724	7	5	21	5	23	Suggest replace "Copenhagen Accord" by "Kyoto Protocol".	Accepted- It was replaced by internationally agreed levels.
18161	7	5	21		23	Add to paragraph: Therefore, constrains limits or constraints on fossil fuel availability cannot be relied upon to limit global GHG concentrations to levels consistent with the Copenhagen Accord [7.4, high agreement; robust Evidence].	Rejected - comment is unclear. Please clarify
18162	7	5	21		23	Alternative paragraph:Therefore, constrains limits or constraints on fossil fuel availability cannot be relied upon to limit global GHG concentrations to levels consistent with the Copenhagen Accord [7.4, high agreement; robust evidence	Rejected - comment is unclear. Please clarify
10488	7	5	21			Delete "or constraints"	Taken into account - text revised.
2392	7	5	22	5	22	why refer to levels in copenhagen accord here and previously to 450ppmv. Chose one and stick with it.	OK. It was replaced by internationally agreed levels.
15936	7	5	22	5	22	shouldn't this cite the Cancun Agreements rather than the Copenhagen Accords, since the latter were never adopted by the UNFCCC, merely 'noted'.	Taken into account - text revised
10489	7	5	22			Not sure if all readers will understand "the Copenhagen Accord" so could add "to limit global temperature rise to below 2oC."	Taken into account - text revised. The legally binding Cancun Agreement now is mentioned.
2820	7	5	24	6	17	These paragraphs understate the scale of the challenge (see detailed comments below). They also read oddly after paragraph 1, which notes that despite a wide array of mitigation policies, we are not on track. I would have expected to see some explanation for this failure.	Taken into account - text has been rewritten considerably. Comment is obsolete.
18037	7	5	24	5	24	Define "low carbon"	Rejected - low carbon is a usual expression.
6163	7	5	24	6	4	This paragraph reads like a grocery list. While there are a lot of concerns the ES needs to address, this would be better if it were split it apart and the transitions smoothed, or turned into a table or more readable figure. As an example, from 5,31 to 5,34 we move from emissions reductions from replacing old coal plants with new gas generation to a comparison of the technical renewable potential to primary energy supply. Not only is "RE" not previously defined, but these two things seem only tangentially connected.	Taken into account- ES has been rewritten
16770	7	5	24	8	4	I don't find these paragraphs that helpful as part of the executive summary -- it reads a bit like a list without real context and I don't see how this is helpful to policymakers or the public. In this chapter, I find sections 7.12.3 and 7.13 the most important parts and likely most helpful to negotiators who should have better understanding of this pathways concept.	Taken into account - general statements were replaced by quantitative ones when possible.
3769	7	5	24	5	28	Long sentence and no clear meaning.	Taken into account - text has been deleted. Comment is obsolete.
12155	7	5	25	5	25	It's more polite to use "relevant", than "deep".	Rejected - the text is about deep emissions reductions, i.e., those higher than 50%
3768	7	5	27	5	27	"Reduced production cost". It should be more useful to add a plot showing past costs and a trend line for the scenario.	Taken into account - text has been deleted. Comment is obsolete.
18163	7	5	28		30	Replace: Although there may be constraints at a regional level, and for individual technologies, at the global level, the combined technical potential of low carbon technologies in the energy supply sector is not the factor limiting their widespread deployment high, despite their limited widespread deployment [7.4, medium agreement; robust evidence]. Alternative paragraph: Although there may be constraints at a regional level, and for individual technologies, at the global level, the combined technical potential of low carbon technologies in the energy supply sector is high, despite their limited widespread deployment [7.4, medium agreement; robust evidence].	Rejected - the global potential might be high, but it does nevertheless allow to achieve high renewable market shares at some locations. The chosen phrasing has been improved to clarify this.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2393	7	5	29	5	30	strange wording about technical potential not being the limiting factor. Of course not that is true by definition. Rephrase.	Taken into account - text has been deleted. Comment is obsolete.
2389	7	5	3	5	3	word form is incorrect there	It is not clear why it is incorrect.
15935	7	5	3	5	3	should read '...emissions in the form of both fugitive methane emissions from fuel....'	Taken into account - text has been deleted. Comment is obsolete.
11909	7	5	3			"in form of"?	Taken into account - comment is obsolete. Text has been deleted.
4095	7	5	30	5	36	The bland statements about the combined technical potential of local carbon technologies not being a constraint; the regional technical potential of RE as a whole being a multiple of global primary energy supply requirements, do not stand up to examination. There should be here and elsewhere in this chapter a proper examination of the power densities of the various forms of renewable energy (a la Vaclav Smil). There should be a proper examination of the implications of these (a la Frederick - Ted - Trainer). There should be, somewhere in this chapter and reflected in the Executive Summary, an examination of each source/form of RE. Only CSP with UHVDC transmission has fair technical potential to meet the chapter's claims. The IPCC Special Report on RE did not withstand careful critical scrutiny (e.g.the work of Graham Sinden is referenced, without mention of the fact that other authors - David MacKay, Chief Scientific Advisor to UK DEFRA (2009), Michael Jefferson in 'Energy Policy' (2008) and IAEE Spring 2012 Bulletin, et al have shown his findings to be at odds with evidence provided by wind energy operators and the Met Office.)	Reject - As the Executive Summary is severely space limited, we simply do not have the space here to go into details on the various literatures. However, many of these controversial issues are addressed in the various sections of the chapter - the idea that technical potential may be constrained by competition, declining resource quality with deployment, land use issues, etc. We do stand by the so-called bland statements as a solid reflection of the literature on technical potentials, but in the body of the text we discuss some of the limits of those potentials.
12317	7	5	31	5	33	Please consider to move the sentence "Significant and relatively...." to line 45 before the sentence about CCS.	Rejected - the text is about fuel shifting, which is different to CCS.
12318	7	5	31	5	33	When describing the advantage of fuel switching, we would like to see a comment about the danger of carbon lock-in (ref section 7.10.5) and the importance of CCS (ref section 7.5.1. line 40-42).	This is discussed at section 7.10.5, but space constraints do not allow to emphasize this in the ES.
15754	7	5	31		33	While this may be true, what is the likelihood that China would retire recently built coal plants anytime soon? Also, replacing the internals of a coal plant (I assume boilers and steam turbines) with a natural gas fired turbine with duct heating doesn't sound as inexpensive as this makes it out to be.	Taken into account - cost statements were deleted.
11759	7	5	31	5	33	Energy must be chosen taking into not only enviromnet but also economy and energy security. To avoid the misunderstanding, [prvided the economy and energy security is not taken into account] should be added after this sentence. Also refer to No.4.	Rejected - space constraints do not allow to qualify efforts to reduce GHG. The cost statement, however, has been deleted.
6244	7	5	31			better reference to low cost	Taken into account - comment is obsolete. No cost information is given now.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10653	7	5	31	5	33	Add a statement coal can be chosen from the view point of energy security.	Rejected - the paragraph is about options to mitigate climate change. Space constraints do not allow for mentioning all side-effects everywhere. For instance, we cannot say that there are risks related to nuclear in every paragraph.
11845	7	5	32	5	33	Current research is demonstrating the potential for unconventional natural gas sources to result in high fugitive methane emissions. This seems to suggest there is significant risk of failing to meet mitigation goals by relying on/investing in natural gas fired power plants to reduce GHG intensity of electricity emissions when upstream (extraction) emissions are accounted for. In fact this very issue is addressed in 7.5.1 - it might be worth noting this earlier in the chapter, since it seems a bit inconsistent.	Taken into account - text revised.
2394	7	5	33	5	34	what does regional technical potential as a whole mean?	Taken into account - text has been deleted. Comment is obsolete.
6245	7	5	33			Why just efficient gas and not a first step more efficient coa, the text states that there are merits in chaging less efficient coal by more efficient coal plants.l	Taken into account - switching to coal is now mentioned as well
15937	7	5	33	5	33	I believe 'regional' here should be 'global'	Taken into account - text has been deleted. Comment is obsolete.
10490	7	5	33			Suggest new para at "The regional...." and at line 41.	Taken into account - text revised.
7713	7	5	33			RE means 'renewable energy'?	Taken into account - text revised.
15755	7	5	34			This seems very optimistic regarding potential of RE supply	Taken into account - text has been deleted. Comment is obsolete.
13284	7	5	36	5	38	Presumably RE was nearly half of new nameplate (i.e. peak) GW installed; however on average RE technologies will tend to operate at a much lower load factor (e.g. <20% for PV, around 30% for onshore wind) than fossil capacity operating at baseload, so TWh generation from RE installed in 2011 is likely to be still considerably lower than that from new fossil plant (RE share might be e.g. 20-25%). Given that this is arguably a more accurate reflection of the share of new capacity, it would be worth adding this (probably in addition to the GW share, not instead)	Taken into account - text has been deleted. Comment is obsolete.
6221	7	5	36	5	38	npmc maturity	Rejected - comment is unclear - please explain.
15790	7	5	37	5	38	"RE accounted for almost half of all the new electricity generating capacity added globally" - because fastest growing RE is intermittent solar and wind, actual kWh generated , not capacity installed, is the key metric since need to take the low capacity factors into account. Thus added kWh will be much less than 50%. Check IEA WEO 2011 (or 2012) for up to date data.	Taken into account - text has been deleted. Comment is obsolete.
14540	7	5	4	5	4	Replace 'a' by 'is'	Rejected - comment seems to be misplaced. It is not clear what the reviewer means. Please clarify.
9467	7	5	41	5	45	This part lacks good balance, listing only negative opinions about nuclear power. Its positive factors such as cost effectiveness and low CO2 emission in life cycle should be added.	Taken into account - there is now a positive qualifier that emphasizes that nuclear is able to provide carbon free electricity. It is however not true that nuclear is cheaper than other mitigation options around the world.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
15756	7	5	41			Is nuclear considered renewable energy in this context?	Taken into account. RE, CCS and nuclear now have separate paragraphs.
18164	7	5	41		45	Replace: Resolutions on many issues remain for the continued use and further expansion of nuclear energy worldwide as a response for mitigating climate change, including efforts to improve overcome most of its the safety, economics, resource sustainability, waste management, and proliferation concerns. Significant efforts are underway to develop new fuel cycles and reactor technologies that address the concerns of nuclear energy use, and the fusion reaction, trying to reduce the unsolved problems of nuclear energy use. Alternative paragraph: Resolutions on many issues remain for the continued use and further expansion of nuclear energy worldwide as a response for mitigating climate change, including efforts to overcome most of its safety, economics, resource sustainability, waste management, and proliferation concerns. Significant efforts are underway to develop new fuel cycles and reactor technologies and the fusion reaction, trying to reduce the unsolved problems of nuclear energy use.	Taken into account - text has been rephrased to increase its readability. Fusion technology is not taken into account as it is not yet demonstrated to be feasible on a commercial scale.
11760	7	5	41	5	43	Adding the [Meanwhile nuclear energy would be still cost effective compared with others(Tidball et al. 2010), ] before this sentence is well balanced. 1.R. Tidball et al.: [Cost and Performance Assumptions for Modeling Electricity Generation Technologies], send attachment by another e-mail.	Taken into account - there is now a positive qualifier that emphasizes that nuclear is able to provide carbon free electricity. It is however not true that nuclear is cheaper than other mitigation options around the world.
9501	7	5	41	5	45	It was shown only the disadvantages of nuclear power, advantages should be shown like cost efficiency , smallness of life-cycle co2 emission (less than PV), reliability, energy security. [1] R. Tidball et al. (2010) Cost and Performance Assumptions for Modeling Electricity Generation Technologies.(attached on email)	Taken into account - there is now a positive qualifier that emphasizes that nuclear is able to provide carbon free electricity. It is however not true that nuclear is cheaper than other mitigation options around the world.
9589	7	5	41	5	45	Please, provide merits of nuclear power in exective summary likewise CCS and RE technologies; nuclear power is stemmed from the need to cost-effectively satisfy rapidly growing electricity demand in the emerging economies, as well as efforts to achieve energy and environmental policy objectives, including mitigating greenhouse-gas emissions and providing a secure, diversified and lowcost electricity supply. (WEO 2011, IEA)	Taken into account - there is now a positive qualifier that emphasizes that nuclear is able to provide carbon free electricity. It is however not true that nuclear is chapter than other mitigation options around the world.
18165	7	5	45		48	Add to paragraph: It is argued that... the capture and storage of CO2 (CCS) provides a means by which fossil fuel emissions can be reduced, with applications including can be dramatically reduced. Applications include most large point sources of CO2 emissions, e.g. fossil fuels production sites, power plants, refineries, chemical processing plants and cement kilns; but CCS lack yet of any kind of evaluation process, using a "large geologic storage capacity" to introduce and keep trapped huge amounts of CO2, regardless of the social and enviromental consequences. Alternative paragraph: It is argued that the capture and storage of CO2 (CCS) provides a means by which fossil fuel emissions can be reduced, with applications including most large point sources of CO2 emissions, e.g. fossil fuels production sites, power plants, refineries, chemical processing plants and cement kilns; but CCS lack yet of any kind of evaluation process, using a "large geologic storage capacity" to introduce and keep trapped huge amounts of CO2, regardless of the social and environmental consequences.	Rejected - It is not at all clear what text this comment is referring to nor is it clear what perceived problem this comment is trying to address. It is not true that CCS "lack of any kind of evaluation process..."

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5738	7	5	45	5	45	I think it should be made clear that CCS technology is not mature therefore "CCS MAY provide a means by..."	Rejected -- no scientific evidence or publications offered to support this comment. As the more detailed text in the body of Chapter 7 (as opposed to the few sentences allotted to this topic in the ES), CCS components are mature. There is no economic rationale to deploy CCS systems at present as they can only be used to reduce CO2 emissions. The term "can" is a sufficient caveat for the executive summary. These "may" issues for CCS are dealt with throughout the chapter. The executive summary can not bring forward every nuance on every topic.
10491	7	5	45	6	4	Change line 45 to "Carbon dioxide capture and storage (CCS) ....". This section seems biased - what about risks legal liability, costs, loss of available power generated etc?	These other issues for CCS are dealt with throughout the chapter. The executive summary can not bring forward every nuance on every topic.
5130	7	5	48			The statement "all of the components of integrated CCS system are in use" needs to be substantiated by references	Taken into account. Please see section 7.5.5 where this issue is addressed in much more detail than is possible in an Executive Summary. The Executive Summary is summarizing what is in the body of the chapter and therefore there is no need for in line citations within the executive summary.
4096	7	5	48	5	49	Storage capacity has been shown to be a constraint well within a century in previous Assessments.	Rejected - not supported by the broad body of peer reviewed literature. Please see section 7.5.5. Yes this is true but we have accumulated new knowledge since the previous IPCC assessments were published. That society learns more as we move forward in time is a good and fortunate thing. The sections on CCS in the chapter discuss this in detail. The executive summary can not bring forward every possible nuanced point. The wording in the executive summary is fine as it stands.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4521	7	5	48	5	48	While components are in use, integrated systems have not been applied to most applications. Suggest adding "...are in use, but integrated systems have not been applied to most potential applications." Otherwise this statement gives a distorted view of the maturity of CCS technology.	Accepted. The text in the ES has been revised to bring forward this nuance more explicitly.
17356	7	5	48			exist and are in use...	Taken into account - text revised.
2390	7	5	5	5	6	swings in our political systems? Rephrase or delete	Taken into account - text has been deleted. Comment is obsolete.
14541	7	5	5	5	5	pre-sets?	Not clear comment. There is no such text in this line.
3765	7	5	5	5	5	"our economy". What does it means? Be more precise using "global economy" for example.	Taken into account - text has been deleted. Comment is obsolete.
4801	7	5	5	5	15	It would be helpful for people not familiar with previous documents to have some info on the dates covered in the AR4 and AR5.	Taken into account - text has been deleted. Comment is obsolete.
10484	7	5	5			Needs a statement to clarify where Chapter 7 stops and chapters 8, 9, 10 begin. Maybe "Use of the transport fuels, heat and electricity produced are discussed in Chapters 8 (Transport), 9 (Buildings) and 10 (Industry)."	Taken into account - comment is obsolete. Text has been deleted. The introduction now clarifies this point as well as the first sentence of the ES.
18156	7	5	7		10	Replace: "decarbonize the global fuel mix" by "rationalize the energy sector". Comment: The failure to rationalize the energy sector, i.e., to implement a better fuel use in transport, industry, etc.; driving a progressive rational and efficient use of energy, diversification of energy sources, technologies and system configurations (including ICT, DG, smart grids, etc.). In this framework, decarbonization is at best a piece of the whole picture of energy and development.	Taken into account - text has been deleted. Comment is obsolete.
18157	7	5	7		10	Alternative paragraph: Energy-related GHG emissions continue to grow; they have increased even faster in the last decade than the three decades previous to this period [7.3, high agreement; robust evidence]. Rapid economic development along with the failure to rationalize the energy sector has driven most of the acceleration in emissions growth in the last decade.	Taken into account - text has been deleted. Comment is obsolete.
10485	7	5	8			TSU needs to standardise Exec Summary formats. E.g. should "7.3" be here or not?	Noted.
16768	7	5	9			Suggest insertion of "has driven demand for energy services" after "economic development" as this helps more clearly decouple economic development as a culprit in growing emissions (we don't want to give impression we dislike economic development).	Taken into account - comment is obsolete. Text has been deleted.
16769	7	5	9			Suggest we delete "decarbonize the global fuel mix" and replace with "deploy low and non-emitting energy technologies". Analysis cited in chapter 7 -- point made that CCS is important component of lower cost mitigation paths. Saying we want to decarbonize the global fuel mix misses that point or negates it and is not supported elsewhere in report via economic analysis.	Taken into account - comment is obsolete. Text has been deleted.
11910	7	5	9			better to say "failure to move toward decarbonizing the ..." Sounds less negative and pejorative	Taken into account - comment is obsolete. Text has been deleted.
6161	7	5			6	The ES isn't effective in explaining the overall arguments and goals of the chapter. This should be clearly established from the opening paragraph. The first sentence is exceptionally egregious – a massive run-on with multiple basic grammatical errors and little clear direction. This section needs to be rewritten to clearly explain the conclusions reached are, and how they are arrived at.	Taken into account - the ES has been completely written in order to increase its accessibility.
12314	7	5	1			Please consider to use shorter paragraphs to make the Executive Summary easier to read. (See chapter 5 for format).	Taken into account - text has been revised.
9236	7	5	18	5	19	Is very strong the sentence: "Fossil fuel resources are abundant and cost competitive with other energy forms" Is necessary said that is true only for the externalities yet are not internalized in the cost of the fossil fuel and the carries energetics	Taken into account - text has been deleted. Comment is obsolete.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13451	7	5	20	5	21	Text : "Left hydrocarbon reserves alone contain two to four times that amount of carbon." There is mounting evidence to suggest that not all reserves can be converted into fossil fuel products within the current economic system - particularly in certain regions and for certain fuel types. Of special concern is the stress on global coal supplies from rapidly increased demand for power generation from China and India. Also, the weaknesses in the global oil supply are a risk to sustainable trade relationships. The cost of the fuel may not indicate the full extent of production inflexibility (scarcity), owing to the importance of energy in all economies, leading to suppressed prices either through policy or market manipulation.	Noted - unfortunately space constraints do not allow an extended discussion of these issues in the ES.
17282	7	5	31	33		In section 7.5.1, it is clearly stated that emissions from NGCC are too high to meet long-term stabilization targets. If the mitigation potential of gas-fired power plants is mentioned, this part of the story should make it to the executive summary as well.	Taken into account - text revised.
9237	7	5	31	5	33	The affirmation is true but unrealistic in the case of replacing coal fired power plants with modern, highly efficient gas fired ones, because China and India will not renounce to use the indigenous coal for to use gas imported if nobody give some guaranties or incentives, or in the actual conditions of technologies transfers	Rejected - the paragraph is about technical options. It does not judge whether there is a willingness to change from a mitigation point of view.
10999	7	5	41	5	43	It is quite unfair since there are only negative point of views regarding nuclear energy. Nuclear energy has also the advantage in terms of cost and low CO2 emission, so such the advantage should be described equally.	Taken into account - there is now a positive qualifier that emphasizes that nuclear is able to provide carbon free electricity. It is however not true that nuclear is cheaper than other mitigation options around the world.
8843	7	5	42	5	43	Why are the issues that nuclear energy has to put effort into improving put in the order that they are? Namely, what justification is there for putting safety first instead of economics? Surely alphabetical order would be preferable.	Rejected - the sequence does not mean that some are more important than others.
8844	7	5	45	5	46	Even though the next sentence addresses the issue, it may be preferable to note from the outset that CCS addresses "fossil fuel emissions" from large point sources. If a vehicle runs on natural gas, there is little CCS can do with a multiplicity of point sources.	Rejected - space constraints do not allow to emphasize everything in the ES. That CCS is applied to large point sources is discussed in section 7.5.5.
7012	7	5 of 135	18	5 of 135	19	Modify sentence beginning in line 18, for the following one: "Fossil fuel resources are relatively abundant compared to other energy forms".	Taken into account - text has been deleted. Comment is obsolete.
7013	7	5 of 135	22	5 of 135	22	Substitute "Copenhagen Accord" for "Kyoto Protocol", or "IEA's Scenario 450". I propose to completely delete from the Report the phrase "Copenhagen Accord", because it hasn't been subscribed, nor ratified by many countries, especially developing ones, which represent the major part of IPCC members.	Taken into account - text revised. Copenhagen Accord is replaced by the Cancun Agreement.
7014	7	5 of 135	24	5 of 135	24	Add "zero," after the first word of this line.	Rejected - there is a difference between low carbon and zero carbon
7015	7	5 of 135	29	5 of 135	29	Add "zero and", after the word "of", and before the word "low", at the final part of the line.	Rejected- it is standard to use low carbon in the sense that it includes zero carbon (e.g., renewables) as well

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
7016	7	5 of 135	41	5 of 135	45	Delete all text from the beginning of line 41 to the phrase "of nuclear energy use.", which ends the paragraph, beginning line 45, because it isn't relevant to stress the further expansion of nuclear energy, taking into account the current prices of nuclear electricity, as well as the overall risks associated to this technology.	Rejected- nuclear is a mitigation option. The ES does not have to judge whether it will be used or not in the future.
10075	7	50				Please add the fuel cost assumptions for coal and gas as LCOE depend on it.	Taken into account - the cost of carbon has been excluded from the results. There is a still on going process to collect additional literature and data concerning gas and coal fired power plants in the context of the recent changes in the gas markets. The final draft will show bars for coal and gas fired power plants together with sensitivities due to CO2 prices.
11862	7	50		51		These pages can be significantly reduced in length. Also, rather than showing table 7.13 which include industrial CO2 emitters, why not convert these values to be comparable to values reported in 7.12? As a reader what I want to know is whether coal (or NGCC for that matter) is cheaper than renewable sources. That isn't answered by what is reported in table 7.13 or the text.	Accepted - the text is revised accordingly.
18082	7	50				To indicate prices for CCS at \$117-131 is way off compared to the budgets of the demonstration projects and the general consensus on what CCS would costs if it were operational anywhere. Some peer reviewed documentation would be helpful or fact checking with the developers. Otherwise delete.	Rejected - the reviewer is asked to provide some literature to support his assessment.
18544	7	50				Blast furnce steel production and cement production are topics that belong rather in Chapter 10. Please liaise with Ch 10 authors accordingly.	Taken into account - the CCS of industrial processes are not shown anymore. They are to be treated in the industry chapter.
9491	7	50	1			For the levelised cost of production the same "logic" must be applied to both power generation and industrial applications; i.e. the cost of production WITH CCS must be the sum of the cost WITHOUT CCS plus the cost of CCS. E.g. the cost of sement with CCS FOAK should be 100 - 122 USD/tonne cement (not 34 USD).	Taken into account - the CCS of industrial processes are not shown anymore. They are to be treated in the industry chapter.
11863	7	50	12	52	7	This section on nuclear comes out of nowhere - jumping from RE, to CCS, to nuclear in this section without transitions makes it hard to follow. Also it seems like the 3 paragraphs on nuclear can be shortened and the key data and conclusions stated more simply.	Accepted - the text is revised accordingly.
3794	7	50	12	51	7	Too much attention dedicated to nuclear power as compared with other conventional and RE sources. This occurs here and in many other parts of this Chapter	Accepted- the discussion of nuclear now is presented in a more concise way.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18083	7	50	15	50	18	EDF 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. <a href="http://www.telegraph.co.uk/finance/newsbysector/energy/9470555/EDF-chief-Vincent-de-Rivazs-nuclear-vision-aims-to-inspire-a-generation.html">http://www.telegraph.co.uk/finance/newsbysector/energy/9470555/EDF-chief-Vincent-de-Rivazs-nuclear-vision-aims-to-inspire-a-generation.html</a>	Taken into account - the cost of nuclear power plants were updated according to the newest available cost data from the BNEF data base. Whereas the highest of these are close to the given specific capital expenditures, the derived LCOE deviate from the ones given in the interview. The LCOE values mentioned in the interview therefor are not considered to be reliable.
10076	7	50	16			LCOE calculated by Bloomebrg only cosisder CAPEX and fuel prices. This should be made clearer.	Rejected - the BNEF's LCOE analysis does take into account the O&M costs, both fixed costs (\$/MW) and variable costs (\$/MWh) are taken into account.
18084	7	50	19	50	21	These ranges (US\$ 42-137) should be reflected in figure 7.12. They are more in line with current reality in the power sector.	Accepted - the figure is revised accordingly.
17375	7	50	19	50	21	in the range of 42 - 48 USD/MWh (Korea) to 97 – 137 USD/MWh (Switzerland).	Accepted - the text is revised accordingly.
3795	7	50	19	50	27	Use coherently MWhel or MWh. Not both.	Accepted - the text is revised accordingly.
3796	7	50	19	50	27	How is possible to understand total nuclear electricity cost at US\$ 47/MWh in South Korea, when only back-end costs are US\$ 52.33/MWh	Rejected - the given back-end costs are \$ 2.33 per MWh and not 52.33 per MWh
10561	7	50	20			Fig 7.12 shows \$90-100/MWh present costs - does not seem consistent with projected costs of \$42-137/MWh	Taken into account - the chart is updated to show the entire cost range of the IEA data.
2788	7	50	20	50	20	\$42-\$137 / MWh for LCOE for nuclear looks extremely low compared to what we are hearing it may cost in the UK and what the recent Finnish and French experiences will come out at. I would look for other references or caveat it. At these costs the only reasonable thing to do is to go for nuclear power.	Rejected - the recent cost estimate in UK, Finland and France are quite close to the upper boundary. The lower boundary is for Korean reactors.
9598	7	50	27	51	2	Please, delete here due to duplication of page 50, line 16 to 18 after indicative.	Taken into account - a repetition now is avoided.
4453	7	50	5	50	11	Explain the difference between cost of CO2 avoided and cost of CO2 captured.	Taken into account - costs of CO2 captured are not discussed anymore.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13507	7	50	23	51	2	Text : "Back-end costs include spent fuel storage, reprocessing and disposal and are estimated at \$2.33 per MWhel...Not included in the levelised costs presented here are the costs associated with low probability - high consequence events such as nuclear accidents and limited operator liability." The extensive and expensive clean up costs of both the Chernobyl and Fukushima Dai-ichi nuclear power plant accidents suggests that decommissioning nuclear reactors and disposing of their radioactive waste stores is for a minority of possible scenarios very much more costly than normal end-of-life procedures - and may interfere with business viability, with knock-on effects on the industry as a whole. For example, there is a lack of qualified nuclear power engineers, considered a direct side-effect from the nuclear power anxiety of the late 1980s.	Noted - the chapter says that the cost associated with the related low probability events are not taken into account in the LCOE.
9233	7	50	3	50	3	After industrial applications to add "Note"	Taken into account - text has been deleted. Comment is obsolete.
13506	7	50	9	50	11	Text : "The additional LCOE costs exhibited by CCS plants (compared to traditional fossil fueled power plants) are to be compared with the LCOE increase of the latter once significant CO2 costs (e.g., via carbon taxes or permit prices) are to be taken into account." To my mind there is a risk that significant CO2 charging is unattainable, through any policy mechanism or treaty - "significant" in this sense meaning a level of CO2 charging/pricing/taxation that could facilitate/stimulate/incentivise a change of direction in energy plant investment. I remain to be convinced that any mechanism in the economy can be used to leverage a carbon price sufficiently high to enable widespread Carbon Capture and Storage.	Rejected no evidence/publications are provided to support the comment. Reviewer is expressing personal opinion about how future climate mitigation policy will evolve.
4454	7	51	15	52	11	This section could be shortened and combined with previous discussions on infrastructure limits, particularly expansion of the transmission network and power plant siting.	Rejected - This material is meant to be presented in the context of the levelized cost comparison, it wouldn't make sense to move it to another section, as suggested by many other comments that note the inaccuracy of LCOE alone as the basis for cost comparisons.
10077	7	51	15		43	Even an electricity system without any RES needs back-up and balancing capacity. There is no reference what these costs are pr MWh.	Rejected - These costs are pretty minor in existing energy markets. They will be more substantial for resources with low capacity credits. The present section focuses on a range of incremental costs associated with low GHG options, in comparison to the existing system.
18085	7	51	15	51	43	This paragraph only gives the estimated additional balancing cost for one technology (wind). Provide the figures for other technologies to have a fair comparison.	Accepted - We have searched for additional estimates of balancing costs for other technologies, but peer reviewed literature is very limited so we will not be able to present a comprehensive comparison. We have, however, added some additional information on balancing costs of solar energy.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2789	7	51	22	51	22	I would be inclined to caveat the costs of balancing. These costs look very low and even today in the UK the cost of commercial balancing is double these figures and we are at nothing like 30% penetration	Accepted - We are reporting the peer reviewed literature faithfully here; however, there are some studies that show higher costs, typically the result of various institutional barriers. We added a caveat that costs may be higher in some regions than what is found in most studies, particularly due to institutional issues.
9599	7	51	23			Please, describe here correctly as EDF operates nuclear plants with load following, which means a flexible operation.	Accepted - text deleted.
10564	7	51	31			Could add ref to SRREN ch 8 again here after "contentious"	Accepted - the text is revised accordingly.
10078	7	51	36		39	The additional transmission costs for wind are mentioned, but not those for other large scale power plants. These data are available from Transmission operators and should be specified as well.	Rejected - no peer-reviewed assessments of transmission costs for other mitigation options was found.
9600	7	51	39	51	40	Please, delete here due to duplication of page 40, line 40 to 45.	Accepted - At line 39-40 page 51 add that the transmission costs of nuclear and CCS are not expected to be high on a \$/MWh basis due to the base loaded nature of these technologies. This distinguishes the text from earlier text on page 40.
10562	7	51	7			Is also the case for large hydro. Could mention	Rejected -the paragraph refers to economic aspects of nuclear usage. The economics of renewable energies are discussed in detail in the SRREN.
10563	7	51	8			If add sub-headings as suggested above add one here "Infrastructure"	Rejected - space constraints do not allow
13508	7	51	40	51	43	Text : "If mitigation technologies can be deployed near demand centres on the distribution network or if these are intended to serve isolated autonomous systems, those technologies may defer or avoid transmission and distribution needs, potentially reducing infrastructure costs relative to a BAU scenario." For this reason, rather than transporting carbon dioxide away for Carbon Capture and Storage, it seems sensible to attempt to recycle waste carbon dioxide at the point of its production - siting Renewable Gas and biorefinery (for liquid renewable fuels) facilities close to gas power plants would be recommended.	Noted - the comment is valid, but the information is too specific to be taken into account in the report. It refers to technical aspects, not to the costs of transmission lines discussed here.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2841	7	52	12	53	21	The discussion of renewables here is unbalanced. While technology costs for renewables do tend to go down over time, the capacity cost curve tends to go up, for the obvious reasons that the cheapest sources and sites tend to be used first (as pointed out on p 28) and integration costs increase with the level of penetration. How this balances out depends on the situation. There is only passing recognition of this inherent tension, in the last paragraph of 7.8.2.2. But it is not a marginal or exceptional situation, as the text implies. In Europe, for instance, as far as the main renewable sources are concerned, we have got almost to the end of the capacity curve for hydro, as remaining sites are increasingly environmentally sensitive, and we are on the upward sloping part of the capacity cost curve for wind as incremental investment moves increasingly offshore. In the US, the marginal cost of meeting an RPS increases rapidly with volume according to at least one study (Crane et al. Energy Policy 39 (2011) 2730-39). Again, the authors may not agree with this assessment but they should at least recognise the underlying tension and the debate.	Rejected - the dependency of integration costs on the market penetration is discussed. The LCOE chart (figure 7.12) shows decreasing and increasing costs depending on the technology. There is no bias in the discussion.
11864	7	52	12	53	21	As with the preceding section, this one is hard to follow. It jumps from topic to topic with long quotes from other source for most of the text. If the goal is just list facts/data then a bulleted list with key findings from each of the quotes would be preferable.	Accepted - text is changed.
18218	7	52	13			Add to text: Although recently detailed studies on CCS costs have been published, the assessment of the cost of large scale plants is still plagued by many difficulties. The CCS technology has been applied to commercial scale projects, however, is not built into any plant carbon, steel or cement therefore large scale costs still have many uncertainties. The costs of renewable energy have been falling steadily since various factors such as best in manufacturing processes and operations, as well as the economic scale. Not so with nuclear plants, whose competitiveness is thought decrease after Fukushima events. Finally, it should be clear that learning cost reduction as a fail safe, the increase of raw materials in recent years has adversely affected the cost of offshore wind power plants and nuclear plants. Alternative paragraph: The CCS technology has been applied to commercial scale projects, however, is not built into any plant carbon, steel or cement therefore large scale costs still have many uncertainties. The costs of renewable energy have been falling steadily since various factors such as best in manufacturing processes and operations, as well as the economic scale. Not so with nuclear plants, whose competitiveness is thought decrease after Fukushima events. Finally, it should be clear that learning cost reduction as a fail safe, the increase of raw materials in recent years has adversely affected the cost of offshore wind power plants and nuclear plants.	Rejected - the paragraph to which the comment refers is addressing the cost of CCS solely. The cost aspects of nuclear and renewables are discussed in other paragraphs. Mixing all technologies would destroy the logical sequence of the section. From a content point most of view the statements referring to nuclear and renewable energies are given in the respective paragraphs.
18086	7	52	13	52	14	It would helpful to a reference to cost/kWh from the references study in the text - or a range from the studies.	Accepted - the numbers of these studies are taken into account in a revised version of figure 7.12.
6454	7	52	13	52	24	See also Page et. al. (2009) for discussion on the paucity of real data	Rejected - publication cannot be considered without additional information. The provided reference is sufficient.
3404	7	52	27		28	It is wrong-unfair to "pick up a winner" in this example. Delete from "e.g...." I could produce tens of respected references with a different opinion about where R&D has to go to reduce cost...	Taken into account - the comment is obsolete, the underlying text has been deleted.
16836	7	52	3		4	It is unclear what this sentence means: "Whether costs will be higher for ...."	Accepted - text is changed.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6194	7	52	33	52	43	It's unclear what this lengthy series of quotes is doing here – if there's another place that makes arguments for the market viability of renewable technologies, point to it in a reference or footnote rather than in this method.	Accepted - text is changed.
9657	7	52				Would read better to address each technology in the same order in each section (applies to all sections)	Accepted - text is changed accordingly.
6195	7	52				The purpose of this section is unclear – why experience curves for ethanol? Many of the other conclusions fall on the obvious side – that nuclear power may increase post-Fukushima is not surprising. Cut.	Taken into account - the experience curve for ethanol is removed. In order to allow for a balanced treatment of the historic cost evolution and short-term expected trends the assessment of the cost of nuclear energy stays.
4455	7	52	12	52	32	The continued discussion on CCS barriers, costs and potentials could be combined with paragraphs on previous pages.	Rejected - the TSU has asked us to constrain cost discussions to chapter 7.8.2.
10079	7	53				Why is there no figure on cost developments for the different thermal power plants?	Noted - there is no figure on the cost development of thermal power plants as their cost evolution has been quite stable in the recent decades.
2790	7	53	1	53	3	There is recent work by the Crown Estate in the UK on offshore wind cost reduction in the coming years which would be a better reference to use than BNEF	Noted - the literature will be assessed once more information on the source is provided by the reviewer.
17376	7	53	14			offshore wind and...	Accepted - text is revised.
16837	7	53	21			It may be helpful to add to end of paragraph: "To conclude this section, it should be stated that under a CO2 constraint that includes a CO2 price, the cost of operating conventional, high emitting technologies increases. Experience demonstrates that as low emitting technologies evolve as they deploy, their costs decrease. This combination causes low emitting technologies to become competitive vs. high emitting technologies, thereby becoming preferred by investors and consumers."	Rejected - the text is not supported by the text (see Figure 7.12) - the LCOE of some low carbon technologies rise.
17753	7	53	22			the title of the section is "economic potential", but the subsequent discussion is on estimates	Noted - it is unclear what the reviewer suggests.
16125	7	53	23	54	2	The uncertainty of fossil, nuclear and renewable resources are fairly different in nature : on fossils it is partly an interest in states or firms to leave uncertainty on the resource; on renewable energy the evolution of technology and industrialization, but also uncertainties in local acceptance by decision makers dominate; in the case of nuclear, financing and acceptance are key. Thus a bias affecting cost curves mixing the three types of resources.	Accepted - cost curves for fossil fuels are deleted.
18087	7	53	3	53	5	We should not talk about "grid parity" in a section that deals with LCOE. Comparing cost of a technology with the retail price (which is more often than not a reflection of political dictate) makes no sense. Use LCOE - also for PV.	Rejected - from a macroeconomic perspective LCOE should not be compared with grid prices. However, for private investors who are capable to exploit it, grid parity can be a big incentive to invest in PV cells.
11548	7	53	3			Please compare this with what you said on p47120-22.	Noted - the text is not contradicting.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6700	7	53	6	53	12	Even if the price of nuclear power will increase, it will not lose its cost-competitiveness against other energies. But this text make impressions that nuclear power is inferior to CCS and renewable energies. This text should be deleted.	Rejected - The text does not state that nuclear power is inferior to CCS and renewable. The verbal quotation of a IEA paragraph says that "the relative economics of nuclear power compared with other generating technologies may deteriorate". On many places on earth, the bunch of other technologies mainly includes conventional ones (gas, coal, hydro). New renewables and CCS are not mentioned here explicitly. At various places the text says that CCS and renewables are more expensive than conventional technologies.
4456	7	53	6	53	12	This paragraph repeats much of what has already been discussed in the context of barriers to deploying nuclear-powered electricity generation plants.	Accepted - text is revised.
16124	7	53	6	53	12	Costs of nuclear may also be driven up by exit of more suppliers, e.g. Siemens of Germany or one or several suppliers in Japan.	Noted - this seems obvious, but no literature is provided to support the argument.
11770	7	53	6	53	12	These sentence should be deleted. It is too much uncertain expression.	Taken into account - the view expressed by the IEA is conserved, while the other statements are deleted. In order to allow for a balanced assessment Joskow is cited, who does not expect a major change in the economics of nuclear power.
9509	7	53	6	53	12	delete this paragraph - Global nuclear generation will be expanding after Fukushima Daiichi accident (The Future of Nuclear Power After Fukushima/Agstract in page 1)(attached on email)	Taken into account - the view expressed by the IEA is conserved, while the other statements are deleted. In order to allow for a balanced assessment Joskow is cited, who does not expect a major change in the economics of nuclear power.
10661	7	53	6	53	12	Please delete this sentence because it is vague with a lot of "may"s.	Taken into account - the view expressed by the IEA is conserved, while the other statements are deleted. In order to allow for a balanced assessment Joskow is cited, who does not expect a major change in the economics of nuclear power.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18545	7	53	6	53	12	The focus on the economic situation for nuclear post-fukushima seems strange. Why is there no more general discussion of historical trends or declining costs for nuclear?	Taken into account - the view expressed by the IEA is conserved, while the other statements are deleted. In order to allow for a balanced assessment Joskow is cited, who does not expect a major change in the economics of nuclear power.
10000	7	53	6	53	12	This part should be deleted completely because the content often uses "may" word and looks speculated. 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.	Taken into account - the view expressed by the IEA is conserved, while the other statements are deleted. In order to allow for a balanced assessment Joskow is cited, who does not expect a major change in the economics of nuclear power.
18088	7	53	8	53	8	Replace "may decide" with "have decided". Siemens stopped in 2011; RWE stopped in 2012; EON and RWE polled out of UK nuclear in 2012.	Taken into account - the underlying text has been deleted due to space constraints. The comment is obsolete.
8845	7	53	3	53	5	The FOD states, "By 2020, grid parity (i.e., competitiveness with grid retail prices) of PV can be expected in many countries provided that sufficient policy support is available (IPCC, 2011a)". It may be worth explaining, perhaps in a footnote, that while residential or small commercial PV systems are competing with the delivered retail price of electricity through the grid -also known as "socket parity" - larger-scale PV systems may be assessed against wholesale generation, sometimes referred to as "busbar parity". Furthermore, Bazilian et al.(2012) 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", citing articles by Breyer and Gerlach (2010), Zweibel (2010), Branker et al. (2011) and Darling et al. (2011). [Bazilian, Onyeji, Liebreich, MacGill, Chase, Shah, Gielen, Arent, Landfear, Zhengrong. Reconsidering the Economics of Photovoltaic Power, BNEF. 2012] [Breyer, C., Gerlach, A., 2010. Global Overview on Grid-Parity Event Dynamics. Presented at the 25th EU PVSEC/WCPEC-5, Valencia.] [Branker, K., Pathak, M.J.M., Pearce, J.M., 2011. A review of solar photovoltaic levelized cost of electricity. Renewable and Sustainable Energy Reviews 15, 4470–4482] [Darling, S.B., You, F., Veselka, T., Velosa, A., 2011. Assumptions and the levelized cost of energy for photovoltaics. Energy Environ. Sci. 4, 3133–3139.] [Zweibel, K., 2010. Should solar photovoltaics be deployed sooner because of long operating life at low, predictable cost? Energy Policy 38, 7519–7530.]	Accepted - text is revised.
8846	7	53	3	53	5	Bazilian et al. argue that, "Grid parity is now largely an outdated concept [...] it is not useful in real-world power sector decision [...] it does not take into account the value of solar PV to the broader electrical industry." The "value of (distributed, non-utility) solar PV to the broader electricity industry" is elucidated by Keyes and Wiedman (2012) and can include: avoided energy costs; avoided capacity costs; avoided line losses; avoided fuel volatility; and, avoided transmission and distribution costs. [Bazilian, Onyeji, Liebreich, MacGill, Chase, Shah, Gielen, Arent, Landfear, Zhengrong. Reconsidering the Economics of Photovoltaic Power, BNEF. 2012] [Keyes and Wiedman, Interstate Renewable Energy Council, "A Generalized Approach to Assessing the Rate Impacts of Net Metering", January 2012]	Rejected - space constraints do not allow to go into the details here.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
11001	7	53	6	53	12	It is seriously problematic since negative indications regarding nuclear energy are described on supposition. Explanation based on clear facts is necessary and important.	Taken into account - the view expressed by the IEA is conserved, while the other statements are deleted. In order to allow for a balanced assessment Joskow is cited, who does not expect a major change in the economics of nuclear power.
18644	7	54				Page 54: Once again a comment on MACs. Here they are said to be a useful summary mechanism but more sophisticated modeling of how supply and demand markets work and interact with each other is required for an analytical underpinning of mitigation policy.	Taken into account - Chapter 6.3.4 with its consistent and sophisticated modelling is now referred back to.
11865	7	54	1	54	2	A useful comparator to what? This is an odd statement, and the reported values aren't compared to anything.	Taken into account - this text is removed as this paragraph has been deleted for reasons of space with reference now made to section 7.4, and the broader discussion section 10.4 of the SSREN
3798	7	54	10	54	10	Typo error. Replace "sort-term" by "short-term".	Editorial
10080	7	54	12		16	The uranium cost are for mining. How much would it change if enrichment is added? What is the energy needed for the enrichment, and which energy source will be used?	Taken into Account - the underlying text on nuclear costs has been removed due to space constraints due to space constraints, and now refers back to section 7.4.2
9601	7	54	28	55	1	Please, move here to page 49 in Chapter 3.	Taken into account - Table 7.5 has been deleted for reason of space and to better link to the MAC discussion in Chapter 3 (especially 3.10.2)
4457	7	54	3	54	16	Resource estimates for various fossil-fuels have been discussed already.	Taken into Account - the underlying text on fossil fuel resources has been removed due to space constraints, and now refers back to section 7.4.1
16127	7	54	3	54	27	Maybe the two paragraphs are redundants and could be summarized in one sentence.	Taken into Account - the underlying text on fossil fuel resources has been removed due to space constraints, and now refers back to section 7.4.1
9658	7	54	3		16	Is it necessary to repeat this?	Taken into Account - the underlying text on fossil fuel resources has been removed due to space constraints, and now refers back to section 7.4.1

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16838	7	54	3		27	Can your replace this with a graph or table with short explanation? The lists embedded in a paragraph are less helpful.	Taken into Account - the underlying text on fossil fuel resources has been removed due to space constraints, and now refers back to section 7.4
10565	7	54	3	54	16	EJ or ZJ issue again	Noted - EJ are preferred as one can span the largest (coal) to smaller types of energy supply resources
2791	7	54	35	54	37	Another weakness of the MAC curve approach is that they tend to look at the simple NPV of the investment rather than what it actually takes to make an investment decision. Real life experience of the MAC curve tends to be very different from the theoretical ones published.	Taken into account - these additional details are referenced back to the discussion in chapter 3 (3.10.2)
3797	7	54	6	54	8	Please, clarify what costs are included in oil production cost. Does it include exploration and transportation to refineries?	Taken into Account - Essentially yes, the text has been reviewed for clarity (and in 7.4.1).
9234	7	54	13	54	13	Nuclear resources don't in table 7.2, it is in table 7.3	Taken into Account - this discussion is removed for reasons of space, referring to the explicit discussion in 7.4.2
13509	7	54	4	54	6	Text : "Total resources of hard coal and lignite (IEA, 2011g) are very large (Table 7.2), and are estimated to cover future demand for many decades at up to 400,000EJ." Although there may be large reserves of coal, they are not necessarily economically viable to mine. If strong coal demand continues, it could be that future demand will not be met, and that even current demand might not be met "for many decades" to come. Some researchers are pointing to Peak Coal being imminent (for example, "A global coal production forecast with multi-Hubbert cycle analysis", Patzek and Croft, Energy 35 (2010) pp 3109 - 3122).	Taken into account - This section has been removed and now refers to section 7.4.1 Note that the overwhelming majority of IPCC and other global scenario and forecast studies find coal supply to be abundant in the decades to come. However there is a small literature on the possible future date of peak coal and the language on the supply of low cost coal has been adjusted to recognise uncertainties

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13511	7	54	40	54	42	Text : "The use of consistent and transparent scenarios (Chapter 6) is one mechanism to make the MAC more transparent to policy makers." MAC curves suffer from one problem that is not discussed here : there is an underlying assumption that the costs of carbon in the graphs can be imposed by a combination of regulatory and general policy means. Since there are many competing forces that will oppose high carbon prices, it is unlikely that the cost of carbon will be higher than \$20/t in today's dollar values. If the price of carbon does rise above that it will be because the general economy has devalued, and so even if the carbon price does reach the region of \$40/t, it will no longer be possible to incentivise the decarbonisation prospects given by today's MAC curves, because everything will cost more in number terms. It is more likely that the cost of energy in general will create a pseudo-carbon price, rather than it being created by a deliberate policy suite. This will come about as the cost of low carbon energy drops to be less than high carbon energy prices. I think it very unlikely in any eventuality that a carbon price instituted by policy, tax or other governance measure, will raise the value of carbon dioxide to the region of \$100/t. I think the cost of carbon in tax or credit trade terms will remain marginal, and the signal of a carbon price or tax will continue to be lost in the economy.	Rejected - no publication provided to support this assertion. It is not just a tenant of environmental economics that a government can price a public externality such as GHG emissions (via a tax or a trading system), it is also a practical element as well and experience with GHG and CO2 pricing is discussed in section 7.12.1. It does not hold that imposing a carbon price will raise the value of "everything" - only those resources and technologies that have substantial carbon requirements in their construction and use will rise and this price increase will be relatively much greater than low emission alternatives
13510	7	54	6	54	8	Text : "Technically recoverable reserves of oil (summarized in Figure 7.8) and Table 7.2) have been classified into a production cost curve with 18,300EJ at a cost of <\$40/barrel to 39,700EJ at a cost of <\$100/barrel (IEA, 2010c)." It is possible that even at this higher end of oil prices, that much oil will remain unrecovered. Since the global economy is so dependent on oil, any price change has to be absorbed, and will cause inflation in general, or contraction in some economic sectors - both of which will affect how much oil can be produced.	Rejected - no publication provided to support this assertion. In fact it has been striking how the rise in global oil prices over the last 10 years has had such a muted impact of global inflation. Furthermore, any rise in global oil prices should boost the investment in relevant economic sectors for oil and hence help to increase supply capacity. However this overall paragraph has been removed with reference now to the discussion in 7.4.1
10277	7	55		55		MAC is not estimated in energy systems, but also in other sectors. I do not think that the table is better to be located in Chapter 7.	Rejected - comment no longer relevant as table 7.5 has been deleted.
4458	7	55		55		This table does not show the MAC of specific technologies. Therefore, the reader cannot assess quickly or easily the relative costs of different technologies and their abatement potential (mass of CO2).	Rejected - comment no longer relevant as table 7.5 has been deleted.
16126	7	55				Very useful table and explanations	Rejected - comment no longer relevant as table 7.5 has been deleted.
17811	7	55				The following paragraph - I have been unable to delete - as accidentally copied - please delete. The point which was under development that there are many forms of transition from very developed to non developed - even in hour developed we have pockets of poverty and gaps in access to energy	Rejected. Not clear what the reviewer is suggesting here.
2235	7	55	1	55	1	In the first line of the table it should be changed to "Expert, BU model" as the McKinsey model is a bottom-up model of the power sector and with expert inputs; and change author to "McKinsey" (instead of Naucler/Enkvist)	Rejected - this comment is no longer relevant as this table has been deleted

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18089	7	55	16	55	16	Add ", renewables and efficiency" after "natural gas"	Rejected. The statement represents a specific example of coal to natural gas substitution.
18219	7	55	19		23	<p>Add to text: The challenges to achieve energy security differ for developed and developing countries (Cherp et al., forthcoming). In addition to securing energy services in the expanding industrial and service sectors, the drive for improved energy services for increasing food security, health, education, and living conditions of the poorest is an important dimension of energy security in developing countries (Kuik et al., 2011). The challenges to achieving energy security differ for developed countries and developing ones. For the latter needs energy supply growth is much higher and therefore the contribution of renewable energy may not be sufficient and will increase reliance on local resources and specific social priorities of the nation. As the largest integrated RES ratios in existing power grids, these exert a greater pressure on the stability of the network. Comment: It is important to note the point of view of developing countries in this matter.</p> <p>Alternative paragraph: The challenges to achieving energy security differ for developed countries and developing ones. For the latter needs energy supply growth is much higher and therefore the contribution of renewable energy may not be sufficient and will increase reliance on local resources and specific social priorities of the nation. As the largest integrated RES ratios in existing power grids, these exert a greater pressure on the stability of the network.</p>	Taken into account. This section has been rewritten to reflect this request.
2842	7	55	25	56	3	Not clear why lack of trade is said to contribute to diversity; a priori, it reduces it by restricting access to indigenous sources only.	Taken into account. Text has been rewritten to reflect this request.
6197	7	55	25	56	2	"With renewable energy resources more evenly distributed around the globe than fossil fuels (WEC, 2007) and being, in general, less traded on the world market, renewables can contribute to diversify the portfolio of supply options." the statement is correct, but limited. In addition to the effect of renewables on the immediate markets, their presence anywhere helps to reduce pressure everywhere on globally-traded commodities.	Taken into account. Text has been rewritten to reflect this request.
6196	7	55	8	55	13	"Policies for improving energy security tend to focus on the interconnected factors of availability of resources, affordability of energy services, efficiency of energy use, and minimizing energy-related environmental degradation. In meeting these criteria of energy security holistically, there will be tradeoffs between technology options that are effective along one dimension, which will have implications for other aspects of security." These statements point to both the importance and complexity of energy security issues. These points could be enhanced by incorporating concepts embodied in the "Index of U.S. Energy Security Risk" (Institute for 21st Century Energy, 2011, <a href="http://energyxxi.org/energy-risk-index">http://energyxxi.org/energy-risk-index</a> ). This index reflects a comprehensive methodology for identifying, quantifying, tracking, and projecting U.S. Energy Security Risks. The methodology takes into account 37 individual metrics that collectively define sub-indexes for Geopolitical, Economic, Reliability, and Environment risks, which in turn define the composite U.S. Energy Security Risk Index. The methodology and data are transparent, primarily using U.S. Energy Information Administration statistics to quantify risks as far back as 1970. Additionally, using forecasts such as those in EIA's Annual Energy Outlook, energy security risks are projected out at least twenty years into the future.	Rejected - space constraints do not allow to go into the details here.
3455	7	55			64	General comment: it should be included a subsection devoted to analyse the opportunities that energy efficiency process have	Rejected. Chapter 7 addresses energy supply.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2792	7	55	5	63	42	If you are looking for ways to cut down the Chapter, I personally wasn't sure that this section added much to the debate.	Rejected - reviewer should provide more specific information what should be deleted. According to the approved outline, the section itself, however, has to stay.
6198	7	55				The connections to climate change are unclear. In this section there are multiple full-page graphs which don't seem necessary. Cut, if connections cannot adequately be justified.	Accepted. Adjusted according to the suggestion. Some sentences that do not have connections with climate change have been removed.
9602	7	55				<p>Please, add nuclear contribution on energy security as follows; in the journal STAIR published by the University of Oxford (UK), Ilnyckyj points out that [1] two factors have resuscitated interest in nuclear power throughout the developed world: high hydrocarbon prices and concerns about climate change. He also argues that [2] political support for nuclear energy exists for several reasons, among them concerns about maintaining secure access to energy. He further notes that [3] the most significant uranium producers globally are Canada and Australia, states likely to be stable suppliers, in contrast with some of the volatile regimes exporting hydrocarbon fuels. Certainly, states such as the U.S., France, and Japan would prefer to be able to secure long-term contracts for access to fuel from rich and stable democracies, as opposed to facing the need to buy [fossil] fuels at volatile prices from states facing both significant internal and regional security challenges.</p> <p>Similarly, in a 2011 peer-reviewed article Corner et al. state that [4] with global energy consumption predicted to increase substantially in the short to medium term, and serious question marks over the longevity of traditional (fossil-fuel based) energy sources, the notion of 'energy security' has become an increasingly important part of energy policy debates; although securing energy has always been a central goal for national governments, energy security has become particularly prominent in discussions about energy policy and environmental sustainability in recent years. Furthermore, the link between energy security and nuclear power is not particularly new. Energy security was part of the justification for the building of the world's very first commercial nuclear reactor at Calder Hall, Cumbria in 1956 and the decision to greatly expand the UK's Magnox reactor program following the Suez crisis. A further program of British nuclear power stations in 1979 again included energy security as a primary motivation. However, while societies have always asked questions about the security of energy supplies, it is only relatively recently that the concept of energy security has played such a prominent role in public policy debates about energy. Spurred on by the parallel debate about climate change, energy security has become an increasingly visible component of the nuclear discourse [5].</p> <p>[1] M. Ilnyckyj (2009) Climate Change, Energy Security, and Nuclear Power, STAIR 4:2 (2009)                  [2] Ibid.                  [3] Ibid                  [4] Adam Corner, Dan Venables, Alexa Spence, Wouter Poortinga, Christina Demski, and Nick Pidgeon (2011) Nuclear power, climate change and energy security: Exploring British public attitudes, Energy Policy 39 (2011)                  [5] Ibid                  See downloaded file "Ilnyckyj 2009.pdf" and "Corner Venables 2011.pdf"</p>	Rejected. The text is a discussion about energy security and not about a specific technology
11943	7	55	12			What does "holistically" mean in this context?? I don't think the usage is correct here.	Accepted. The term 'holistically' has been taken out

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17934	7	55	12	55	13	Usage of the term 'trade-off' is not consistent with agreements reached in Wellington (p. 35) whereby the term 'trade-off' might convey the impression "that a balancing of positive and negative side-effects of mitigation measures is being carried out... Such decision-making aspects" should be left to the policy chapters.	Rejected. It makes perfect sense to talk about 'trade-offs' in the context of energy security. It is relevant in this section.
4786	7	55	13	55	16	This sentence is wrong or partly right "Such tradeoffs include the construction of regional interstate natural gas pipeline and hydroelectric projects that are aimed at enhancing availability of supply, but may be accompanied by unintended social and environmental impacts". This sentence should be more balanced or remove as not all HPPs have negative impacts. Indeed there are numerous example of good practices for trans-boundary hydropower projects (examples could be provided on request). If the project is developed in a sustainable way, using adequate guidelines, the trans-boundary approach should have been undertaken! Reference to international sustainable guidelines, such as the Hydropower Sustainability Assessment Protocol from International Hydropower Association could be relevant (+ IPCC/SRREN as reference).	Taken into consideration. The section has been re-written to address this request
6701	7	55	4			It should be noticed that nuclear energy contributes to energy security.	Rejected. The text is a general statement about energy security and not reflecting on specific technology
11771	7	55	4	56	7	In this section, energy security for nuclear power should be mentioned. Ilyckyj indicates most significant uranium producers, Canada and Australia, states likely to be stable suppliers, in contrast with some of the volatile regimes exporting hydrocarbon fuels. Also once fuel rods charge into the reactor, it is possible to operate approximately one year. Such merits should be added. 1.M. Ilyckyj:[Climate Change, Energy Security, and Nuclear Power], send attachment by another e-mail.	Rejected. This is a general statement about energy security and not reflecting on specific technology
10662	7	55	4	56	7	In this section, role of nuclear power should be mentioned. Ilyckyj indicates most significant uranium producers, Canada and Australia, states likely to be stable suppliers, in contrast with some of the volatile regimes exporting hydrocarbon fuels. Also once fuel rods charge into the reactor, it is possible to operate approximately one year. Such merits should be added. 1.M. Ilyckyj:[Climate Change, Energy Security, and Nuclear Power], send attachment by another e-mail.	Rejected. This is a general statement about energy security and not reflecting on specific technology
9371	7	55	4			This section should also mention the importance of nuclear power plant from the energy security perspective.	Rejected. The text is a discussion about energy security and not about a specific technology
11538	7	55	5			The authors may wish to consider to frame the issue of energy security at different scales: global, regional, national, sectoral, individuals/family. This may help to structure the problem and aspects policies may be aimed at.	Rejected. This is outside the scope of the chapter
9620	7	56	1			Please, insert the following sentence after (WEC, 2007); and renewables are supplied by balancing services of flexible generation, smart grids, strong interconnections between grids or energy storage technologies, such as pumped hydro, compressed-air and large-scale batteries.(IEA, WEO 2011)	Taken into consideration. The text has been deleted in the interest of having a shorter and sharper section
11944	7	56	1			Use WEC 2010. It is a much newer survey of resources. Other than year, same reference	Noted
11946	7	56	13			Think you mean just return, not "marginal return"	Taken into consideration. The section has been re-written to address this request
11541	7	56	13	56	15	This may be misleading. The figure shows indeed that (eg 2005 data) that up to 100 GJ a higher HDI is associated with a higher energy consumption. However, beyond that there is not even a marginal increase in the data points, it is only because the fitting curve is monotone that you draw that conclusion. Similarly in the lower half: beyond 2.5 tC there is no trend, at most a negative trend: this is an artefact of the fitting curve.	Accepted. The text has been adjusted to address the reviewer's question.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18220	7	56	15		17	Furthermore, for constant energy and carbon levels the HDI increases over time, indicating that certain levels of human development are achievable in an increasingly efficient manner (Steinberger and JT Roberts, 2010). Comment: It is possible to achieve high levels of impact of life without necessarily increasing power consumption as outlined in the design capitalist. With a policy of rational use of energy can meet this goal. Alternative paragraph: Furthermore, for constant energy and carbon levels the HDI increases over time, indicating that certain levels of human development are achievable in an increasingly efficient manner (Steinberger and JT Roberts, 2010).	Rejected. The reviewer's amended sentence is identical to the one in the chapter.
4460	7	56	18	56	32	Elements in this paragraph repeat earlier discussions of cost-competitiveness and LCOE of electricity generation from various energy sources.	Accepted. The sentence has been deleted
18090	7	56	20	56	20	write "hydro, wind or solar"	Taken into account. Wind has been added but small-scale remains.
18091	7	56	20	56	20	Replace "can be" with "are in many places"	Accepted. The text has been adjusted to reflect the reviewer's suggestion.
18092	7	56	22	56	24	Mentioning nuclear while excluding (some) grid-based renewables contradicts previous sections and does not seem to be in accordance with the electricity cost of new capacity? Add "onshore wind" after "fossil fuel based generation". Delete "along with nuclear". Unclear sentence: "less costly options" than what? Delete reference to externalities.	Taken into account. The section has been re-written to reflect this request
3799	7	56	22	56	22	"Fossil fuel based generation are often the less costly option". I understand this is only true for coal or, in special circumstance, for NG if there is no exportation market for this fuel.	Taken into account. The section has been reflect the reviewer's request.
10081	7	56	23			change "are often the less ...." to were often the less ...." This would be in line with Figure 7.12 (updated with Q3 202 values)	Taken into consideration. The text has been deleted in the interest of having a shorter and sharper section
18093	7	56	24	56	26	Delete or adjust the sentence: Comparing levelized cost with energy prices is comparing apples and oranges - especially since this sentence relates to the previous sentence which talks (more correctly) about the cost of new build capacity. Levelized cost of many conventional technologies are higher than existing energy prices in many markets, as well - energy prices are to a great extent a function of policy, rather than technology costs. 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. We need to decide whether we want the paragraph to be about energy poverty or cost competitiveness of technologies. Including both elements in one makes the reader confused and makes her draw the wrong conclusions, from what seems to be intended with the paragraph.	Accepted. The sentence has been deleted.
10082	7	56	25			existing energy prices: Does this include fuel subsidies and other support mechanisms mentioned by the Joint report by IEA, OPEC, OECD and World Bank on fossil-fuel and other energy subsidies: An update of the G20 Pittsburgh and Toronto Commitments <a href="http://www.oecd.org/env/49090716.pdf">http://www.oecd.org/env/49090716.pdf</a>	Taken into consideration. The text has been deleted in the interest of having a shorter and sharper section

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18094	7	56	25	56	32	Delete "renewable" in line 25. LCOE of all technologies are higher than the retail prices in markets with regulated prices - and that is most markets of the world, including the EU (referenced in line 30). If you want to make reference to energy affordability and fuel poverty in the EU (which is probably not the worst affected place on the globe), the main reason for the emerging problem should be clarified: it is rising gas prices! The section is structured to give the impression that renewables cause fuel poverty, by confusing prices and cost, while ignoring that gas prices are the reason for the worsening of the situation.	Taken into account. The section has been re-written to reflect this request
4459	7	56	26	56	32	There have been criticisms of the fuel poverty threshold of 10% of household income [cite]	Taken into account. The section has been re-written to reflect this request
16128	7	56	29			Boardman 2010 is not in the bibliography	Noted.
11539	7	56	29	56	32	Suggest to delete - if you want to shorten text	Accepted. The text has been deleted in the interest of having a shorter and sharper section
9603	7	56	3			Please, replace limit with alleviate and remove the heavy as the following reason; the contribution of variable renewables to the adequacy of a system is often significantly lower (per MW of installed capacity) than that attributable to other energy options. Because only a fraction of total capacity has a high probability of running consistently, variable renewables have limited capacity value. (IEA, WEO 2010)	Taken into consideration. The text has been deleted in the interest of having a shorter and sharper section
16840	7	56	31			What is the formal definition of "sustainable energy"? Is not the goal CO2 emissions reduction?	Taken into consideration. The section has been re-written to address this request
16841	7	56	32			Would it be helpful to add to end of paragraph: "It may be noted that as household incomes increase as economies grow that the "affordable" energy bill can include a growing share of low emitting energy supply."	Taken into consideration. The text has been deleted in the interest of having a shorter and sharper section
9372	7	56	5	56	7	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. The text does not read as the reviewer indicated. In fact, the text partly agrees with what the reviewer has identified.
11945	7	56	6			What does "stability" mean in this context?	Taken into consideration. The text has been changed to 'system stability'
16839	7	56	9		10	Is this true? Have you demonstrated that it is not instead that higher levels of development drive greater energy use -- energy availability may be needed for development, but it does not in itself drive development.	Accepted. The text has been adjusted to address the reviewer's question.
17935	7	56	4			Please insert 'domestic' between 'existing' and 'reserves' to clarify the sentence.	Taken into consideration. The sentence has been taken off in a new section review
9659	7	56				I think this is an appropriate section to discuss the issues around developing countries not having the financial, technical or institutional capacity to manufacture or install RE. The financial and Eurozone crisis have impacted significantly on the funding and support available.	The financial barriers are discussed in 7.10.2. The correctness of the second part of the comment can not be assessed due to lack of references provided by the reviewer.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
15130	7	56	18	56	18	It seems to me that is necessary to explain as well that in a lot of developing countries, in rural areas, the highest percentage of expenditure on energy respect to the level of income, is observed in the population that has the lowest income and expenditure on energy. As well is necessary consider that to attend the needs of energy for cooking important areas of forests are deforested, it means emission of GEI	Taken into consideration. This issue is picked up in a separate box on least developing countries
11542	7	56	8			This section should be coordinated with Chs 2-4 authors	Taken into consideration.
18221	7	57				Comment: The table and the quoted text makes clear that maintaining patterns of energy production and consumption of the capitalist system, achieve less and less impact on the human development index (high energy consumption patterns, and declining incidence in IDH). This indicates that energy savings and an appropriate policy for the reduction of GHG, in developed countries, only marginally sacrifice the welfare of their inhabitants.	Noted
11540	7	57	12			define 'modern'	Rejected. This is a reference to reflect a common use of work in energy literature to mean the opposite of traditional, i.e.. Informal harvesting of bioenergy, and using rudimentary inefficient appliances
11947	7	57	5			"per capita" not "per capital"	Noted
4651	7	58		58		I would argue with the number of 2.663 billion people dependent on biomass for cooking. My estimate is about 3 billion. Also, many people in developed countries rely of biomass for heating the house and water. The stove may also be used for cooking and beverage preparation! Thus, a figure for cooking and heating should be well in excess of 3 billion. The population in Africa may well double by 2050 to reach 2 billion. If nothing is done to increase agricultural productivity, the effect on biomass resources (and water availability) may be serious.	Rejected. The reviewer does not produce the reference apart from his own estimate
4652	7	58	6	58	6	"The provision of access to clean, efficient, affordable and reliable energy services entails multiple benefits ---". There is no such thing as 'efficient' energy. It is the way it is used that determines efficiency. Leaving a light on all day and night is generally not an efficient use of electricity! Granted unprocessed biomass usually has a lower energy value than other forms of energy, and at present it is mainly used in relatively inefficient devices. However, there is considerable scope for improving their efficiency and lowering pollution from them, see Barnes D.F., Priti Kumar, Keith Openshaw (2012). The above statement implies that current biomass use is bad. But its use in existing and new forms will be around indefinitely and be a major RE. This is not conveyed in this chapter.	Rejected. This is intended to suggest system efficiency, i.e. using improved cook stoves is more efficient use of resources than traditional systems. Also what the reviewer is suggesting to add is way beyond the scope of the chapter
11948	7	58	4			It is really "population distribution" not population. Figure would be improved is total population without access was shown. As such it is somewhat meaningless.	Accepted.
17937	7	58	8			Please add 'for GHG mitigation' after 'renewable energy' to clarify that is is about co-benefits of GHG mitigation rather than energy policy.	Accepted.
17828	7	59				The development of the environment and health effects of energy is rather disappointing - we invite to consider the following papers: Markandya in Lancet 2007 and 2009; Kirk Smith in Global energy assessment and Menne and Kreisel, energy and health in the European Region (forthcoming)	Taken into account. The GEA chapter was already cited, the Markandya paper has been added to the list of similar analyses. A forthcoming paper could not be considered.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17754	7	59	28			replace "important source" by "major emitting source"	Rejected. I can see what this is getting at, distinguishing anthropogenic emissions from other sources, but I do not like the language
13204	7	59	29	59	30	This sentence should be clarified : what is meant by categories ? An estimate of the number of deaths would be more informative,showing that coal is the most dangerous energy source for humanhealth	Rejected. The sentence says that fossil fuel causes a large number of different types of impacts and that overall fuel use explains these impacts well. To explain this study in detail would require more space than we have available here, but going to the abstract of the reference provided will tell the reviewer exactly what is meant here. This comment lacks a peer-reviewed reference to support the claim that coal is the most dangerous energy source by causing most deaths.
11772	7	59	30	59	32	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.	Rejected. No reference cited clearly demonstrate that reducing coal combustion offers the largest co-benefits of climate mitigation.
16843	7	59	30			Suggest adding after "fossil fuel combustion," the following: "from sources with no pollution control technology" Many coal fueled power plants operate with very low emissions of other pollutants if they have the appropriate technologies and are operated correctly.	Rejected. Thank you for the suggestion. We would like to explore this further, but there are several issues and we are under very tight space constraints here. The literature cited supports our claim, so we would just like to let it stand here.
10001	7	59	30	59	32	This part should be deleted totally. 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.	Rejected. Coal clearly has the highest impacts, even cleaner coal technologies still have relatively high impacts compared to other energy technologies.
9373	7	59	30	59	32	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. Coal clearly has the highest impacts, even cleaner coal technologies still have relatively high impacts compared to other energy technologies.
11543	7	59	33	60	3	Could be streamlined	Rejected. The comment was too brief to carry any meaning.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16129	7	59	35	59	37	SRREN did not compare nuclear and renewable energy, but did the full assessment of the latter. The two kinds of resources do not have the same kind of advantages or drawbacks, in particular regarding irreversibilities and long term impacts. Nuclear should appear in another sentence.	Taken into account. SRREN did review all published LCAs of nuclear power, but did not take into consideration other environmental assessments, as it did for the renewables. Language has been adjusted to be more precise about this distinction.
9660	7	59	35		43	By not mentioning what the impacts of RE and nuclear energy are in this report and simply referring to the SRREN, it gives an unbalanced view in comparison to fossil fuels.	Rejected. The claim for an unbalanced treatment would need to be better substantiated. Here, additional material demand is discussed. There is no space for a more extensive discussion
7742	7	59	36	59	37	In nuclear, again, being treated as renewable energy here?	Taken into account. Nuclear is treated as an energy source with low GHG emissions.
18095	7	59	39	59	40	It would be difficult to find a study justifying this sentence. Renewables have significantly lower environmental and health effect than fossil fuels, including gas. Replace "have impacts comparable to clean natural gas systems and much lower than coal or oil" with: "have impacts much lower than coal, gas or oil".	Taken into account. SRREN did review all published LCAs of nuclear power, but did not take into consideration other environmental assessments, as it did for the renewables. Language has been adjusted to be more precise about this distinction.
16844	7	59	39			Suggest adding after "pollutants" the following: "many of which can be controlled at a reasonable costs with pollution control technology."	Rejected. A longer discussion would be necessary here. Emissions are still substantial even after SOTA pollution control, especially for mercury.
11867	7	59	44	59	44	While it is true that some energy technologies require special materials, I don't think it is defensible to say they need "additional materials". For example, steel and concrete use in nuclear power plant construction outstrips the mass required for just about every other application (except perhaps large hydro) but certainly biomass power plants. Rare earths are used in permanent magnets - and while such magnets are used in wind turbines, they are used in greater volume in consumer electronics (and perhaps in hybrid and electric vehicles in the future...which are best referred to as energy efficiency technologies). These are just 2 examples that seem to contradict the statement regarding "renewable energy technologies...require additional materials". Anyway, the point is that while the issue of critical energy materials is important, it needs to be reframed in terms of "energy technologies" rather than "renewable energy technologies".	Rejected. The reviewer should consult the cited references to see an analysis of these issues.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16845	7	59	44		46	This analysis very likely leaves out the fact that as inputs become more scarce from existing sources that the price increases -- when this occur, more costly supply sources are then exploited so that you never actually "run out of" the particular material. Before you run out, prices go up and you look elsewhere for supply --- if prices go and stay really high, you find a different material or figure out how to do w/much less of it.	Rejected. For some metals, this is correct. For other metals, there are real access issues because you either reach the mineralogical barrier or because the metals are co-produced with other metals whose demand may not increase. See the literature cited here and the references therein for a more detailed treatment of these aspects. In any case, energy needs, pollution, land and water use increase with the amount of ore mined as we get to lower ore grades.
16842	7	59	5			Would it be helpful to policymakers to see this at end of paragraph? "The fact that local economies can grow while absorbing the higher cost of renewable energy resources may provide some evidence that economic growth can still occur with a modest CO2 price that would drive lower cost CO2 reductions."	Rejected - please provide peer-reviewed literature that supports the statement.
5956	7	59	6			Balance: It should be acknowledged that the health benefits of access to secure energy/electricity supplies significantly outweighs the damages associated with electricity production (as evidenced by life expectancy rates). While a discussion of the relative health impacts of different technologies has value, net health impacts (improvement) depends on their relative costs (affordability)	Taken into account - Please note that the benefit of energy access is extensively discussed in section 7.9.1. We cannot afford to repeat this here. Also, this section compares different technologies that all provide access, and at such, there is no imbalance among technologies.
4787	7	59	35	59	36	I am not sure that "nuclear" issue was addressed in the report SRREN ... the renewable technologies presented were: bioenergy, direct solar energy, geothermal energy, hydropower, ocean energy, wind energy	Taken into account. SRREN did review all published LCAs of nuclear power, but did not take into consideration other environmental assessments, as it did for the renewables. Language has been adjusted to be more precise about this distinction.
17938	7	59	40	59	41	It would help to clarify that the impacts do not relate to GHG emissions but to other impact categories. Additionally, particularly bioenergy technologies (rather than RE technologies in general) have a range of ecological impacts.	Taken into account. SRREN did review all published LCAs of nuclear power, but did not take into consideration other environmental assessments, as it did for the renewables. Language has been adjusted to be more precise about this distinction.

**Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7**

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13203	7	59	6	62	26	Rather than having those two paragraphs, It would more policy relevant to devote one paragraph to health effects and a second one to environmental effects and to discuss in each paragraph the possible effects of normal functioning and technical risks	Rejected. There are many different impacts and no way to aggregate ecosystem-related ones into a single category, so that a presentation on a more aggregate level seems more easy to us.
12625	7	6	1	6	1	The statement "unevenly distributed" needs clarification as it is a relative term. It should also be referenced.	Rejected - unevenly simply means that there are different storage capacities at different sites.
12668	7	6	1	6	1	The statement "unevenly distributed" needs clarification as it is a relative term. It should also be referenced.	Rejected - unevenly simply means that there are different storage capacities at different sites.
15757	7	6	1		2	This sounds expensive. What would the carbon price have to be to make this economic?	Taken into account - comment is obsolete. Text has been deleted.
15801	7	6	1	6	4	Moving CO2 by ship will not be practical given transport costs. Also biomass-CCS will be limited in impact due to limited supply to meet demand and air quality control issues	Taken into account - the first comment on ships is obsolete. Text has been deleted. Issues related to bioenergy usage are discussed in the bioenergy annex of chapter 11.
18168	7	6	12		17	Comment:.....for least developed countries, their dissemination will imply a massive technology transfer coupled with financial support. In favourable settings, some of the low carbon energy supply technologies are already economically competitive: for example, largescale RE power supplies can be competitive with fossil fuel alternatives, while smaller-scale hydropower, solar photovoltaics, and modern bioenergy systems can sometimes be less expensive than other alternatives to increasing energy access in off-grid, remote and rural areas [7.8, medium agreement; medium evidence]. Comment: Although it is stated Actually, it would be equally valid mentioned to developing countries (not only the least developed) relative the issue of technology transfer and financial support necessary for the dissemination of technology mitigation. Such as it appears in the text, it suggests that businesses Commercial are ahead of the technology transfer agreements and financial support.	Taken into account - comment is obsolete. Text has been deleted.
18169	7	6	12		17	Alternative paragraph: In favourable settings, some of the low carbon energy supply technologies are already economically competitive: for example, largescale RE power supplies can be competitive with fossil fuel alternatives, while smaller-scale hydropower, solar photovoltaics, and modern bioenergy systems can sometimes be less expensive than other alternatives to increasing energy access in off-grid, remote and rural areas [7.8, medium agreement; medium evidence].	Taken into account - comment is obsolete. Text has been deleted.
16771	7	6	12			Suggest you insert "or purchases" after "technology transfer" -- the agreement could include trade in emissions with BAU paths for developing countries which would provide the means to pay for the technology purchases. Technology movement need not depend on the goodwill of the wealthier countries.	Rejected- a technology transfer will be required anyway - independent of the source of the financial means to pay for it. The financial transfers stated may well be due to a CDM-like mechanism.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13034	7	6	13	6	17	The sentence beginning with "In favourable settings....." implies that only small-scale hydropower can be cost competitive and only in off-grid locations. The sentence could be improved by splitting into two sentences and rephrasing as follows: "In favourable settings, some of the low carbon energy supply technologies are already economically competitive: for example, largescale RE power supplies including hydropower, wind energy, and others can be competitive with fossil fuel sources. In addition, smallerscale projects including hydropower, solar photovoltaics, and modern bioenergy systems can sometimes be less expensive than other alternatives to increasing energy access in offgrid, remote and rural areas."	Taken into account - comment is obsolete. Text has been deleted.
18039	7	6	15	6	16	Small wind should be added here. Used with diesel generators, the cost of the turbine are often much lower than the extra fuel costs that would be incurred without the turbine.	Taken into account - comment is obsolete. Text has been deleted.
5939	7	6	17	15		The inference that large scle RE systems can be competitive with fossil fuel technologies is subject to a number of qualifications. In particular in relation to variable RE sources, this statement does not appear to encompass the total costs of ensuring continuity of supply	Taken into account - text has been deleted. Comment is obsolete.
18170	7	6	18		23	Comment: Power production is the largest single emitting sector (40% of energy-related GHG emissions) and it will play a major role in transformation scenarios with deep cuts of GHG emissions [7.12, high agreement; robust evidence]. The diverse characteristics of various forms of lowcarbon energy supply suggest that combinations of options rather than a single dominant source will minimize the cost and technical integration challenges of achieving low GHG concentrations. Comment: It is necessary to promote integrated planning of energy use of different regional energy options, so that traditional sources of fossil energy and alternative energy sources complement each other, achieving greater energy efficiency to better meet the challenges related to the emissions of greenhouse gases.	Taken into account - comment is obsolete as the referenced text has been deleted.
18171	7	6	18		23	Alternative paragraph: Power production is the largest single emitting sector (40% of energy-related GHG emissions) and it will play a major role in transformation scenarios with deep cuts of GHG emissions [7.12, high agreement; robust evidence]. The diverse application characteristics of various forms of lowcarbon energy supply suggest that combinations of options rather than a single dominant source will minimize the cost and technical integration challenges of achieving low GHG concentrations.	Taken into account - comment is obsolete as the referenced text has been deleted.
5940	7	6	18	33		Lack fo clarity as to what is being stated	Taken into account - text has been deleted. Comment is obsolete.
6164	7	6	18	6	20	Tie back to page 5, lines 2-3. Perhaps rephrase as "Among the energy sector activities of energy extraction, conversion, storage, transmission and distribution processes, power production is the largest single activity."	Taken into account - comment is obsolete as the referenced text has been deleted.
6444	7	6	18	6	18	The sentence should begin: "Electric power production..." or "Electricity production..."since power is a generic term. I suggest the use of the word 'power' be considered carefully throughout the report and that 'electricity' or 'electric power' are used when electric power is what is meant . See also page 13, ln 4; page 16, ln 6; page 18, ln 29; p75, ln 10	Rejected - power is a term that is well known in the energy sector literature.
5146	7	6	18		33	This paragraph could be made more to the point - it is difficult to understand - for instance the sentence starting a line 25: what is ment by " --- will necessitate systemic changes in the remaining set of ---" the relationship between "key low GHG ----" and "remaining" needs clarifying (ES needs to have a precise, easy to comprehend message - this is not always so)	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
10492	7	6	18			Page 6 states energy sector has 45% of energy-related GHG emissions yet here states 40% for power generation alone - BUT page 15 line 16 says 40% is "electricity and heat generation alone". So which is correct? And what is the 5% for? Not transport. Need to check.	Taken into account - text has been deleted. Comment is obsolete.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
14407	7	6	2			This sounds more upbeat on CCS than the usual view	Accepted - text on CCS has been rephrased.
5131	7	6	22		24	The sentence is not clear!	Taken into account - comment is obsolete as the referenced text has been deleted.
2395	7	6	24	6	27	That is one strange sentence. Shorten and rephrase	Taken into account - comment is obsolete as the referenced text has been deleted.
18172	7	6	24		33	Add to paragraph: The unavailability of any one key low GHG energy supply option will necessitate systemic changes in the use of the remaining set of low GHG resources, technologies and demand measures, for emissions will rise, increasing both marginal and total cost of achieving a prescribed emissions limit [7.12, high agreement; medium evidence]. Infrastructure and integration issues vary by mitigation technology and region, and while they are not generally technically insurmountable, such issues must be carefully considered in energy supply planning and operations to ensure reliable and affordable energy supply and may require changes in patterns of energy production and use, and consumer expectations, and result in higher energy costs [7.6, medium agreement; robust evidence]. These factors may also apply to deployment of fossil fuels [7.4, high agreement; robust evidence].	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
18173	7	6	24		33	Alternative paragraph: The unavailability of any one key low GHG energy supply option will necessitate systemic changes in the use of the remaining set of low GHG resources, technologies and demand measures, for emissions will rise, increasing both marginal and total cost of achieving a prescribed emissions limit [7.12, high agreement; medium evidence]. Infrastructure and integration issues vary by mitigation technology and region, and while they are not generally technically insurmountable, such issues must be carefully considered in energy supply planning and operations to ensure reliable and affordable energy supply and may require changes in patterns of energy production and use.	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
6793	7	6	28	6	29	"Infrastructure and integration issues vary by mitigation technology and region, and while they are not generally technically insurmountable..." Grid integration of renewable energy is far from insurmountable. Numerous utility studies have shown grid integration costs of less than a half-cent US per kWh for penetrations up to 25%. In the U.S. many utilities have easily met many renewable energy penetration goals associated with renewable portfolio standards far ahead of schedule. And installing the infrastructure is a welcome opportunity when jobs are badly needed.	Rejected - space constraints do not allow to go into the details in the ES
4097	7	6	3	6	3	At every point in this chapter the source of bioenergy needs to be provided in view of the already seriously adverse effects of using some forms for bioenergy/biofuel purposes - including impacts on food availability, food prices, social stability, and water resources.	Taken into account - there is a new annex to chapter 11 which deals with the issues related to bioenergy usage. Space constraints however, do not allow to mention these explicitly in the chapter 7 every time bioenergy is mentioned.
3770	7	6	31	6	31	"consumers expectations". Usually the consumer is only concerned with the availability of some energy services and not with the primary energy sources. Thus, "consumer expectations" must be better clarified.	Rejected - some options to deal with variable input from RE sources are realized at the consume level (e.g. demand response).
3771	7	6	32	6	33	This sentence is not necessary. It is already included in the previous one.	Accepted - text revised.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
15802	7	6	34	6	41	Co-benefits are valuable but how do you quantify these, both physically and economically? Just talking about these will drive technology deployment or convince policy makers.	Noted - the fact that co-benefits are hard to quantify does not mean that they are not occurring.
18174	7	6	34		40	Add to paragraph: There are often co-benefits from the use of mitigation technologies in the energy supply sector, such as reduction of air pollution, employment opportunities, lower energy production related fatality rates, better energy security, improved energy access and reduced vulnerability to price volatility [7.9, high agreement; robust evidence]. At the same time, however, many low carbon technologies can have substantial negative ecological impacts, though social and cultural appropriate technology selection, in the context of neighborhood its those impacts can be mitigated to a degree through the appropriate selection, design and siting of the technology [7.9, high agreement; robust evidence]. Comment: Meaning the territorial (in a geographical wide sense) and environmental (in its whole sense) conditions of the project.	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
18175	7	6	34		40	Alternative paragraph: There are often co-benefits from the use of mitigation technologies in the energy supply sector, such as reduction of air pollution, employment opportunities, lower energy production related fatality rates, better energy security, improved energy access and reduced vulnerability to price volatility [7.9, high agreement; robust evidence]. At the same time, however, many low carbon technologies can have substantial negative ecological impacts, though social and cultural appropriate technology selection, in the context of neighborhood.	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
5327	7	6	34	6	37	The co-benefits of "employment opportunities" and "better energy security" are highly questionable. Where does the alleged high evidence come from? Employment effects are predicted mostly by bottom-up models, but not by CGE models. If energy becomes more expensive through deployment of renewable energy, aggregate employment typically goes down.  Energy security: Coal is highly abundant on the world market and prices are rather stable. (This is a driver for global warming). By contrast, the supply of renewable energy, notably wind and solar is highly volatile, leading to additional costs for storage and/or backing up of energy supply gaps by flexible power plants, notably gas turbine power plants. So the increase of energy security by the deployment of renewable energy sources is highly questionable. Where is the evidence from scientific research?	Taken into account - the dispute on this issue now is shown in chapter 7.10.4. The level of confidence of the paragraph in the ES has been reduced. The wording however is the same as it is true that job creation opportunities exist. Lost jobs are counted under "negative impacts" a couple of lines later.
12029	7	6	35	6	35	There must be both positive and negative opportunities for employment.	Rejected - co-benefits comprise employment opportunities. Lost jobs are to be counted under negative side-effects (or impacts).
12917	7	6	35	6	35	add 'cost savings'	Rejected - in general low carbon technologies are still more expensive than fossil ones.
6222	7	6	36	6	36	Many mitigation technologies increase price volatility - cf negative power prices in FRG due to excess wind	Rejected - what is meant here are the prices of imported energies.
16772	7	6	36			Can you somehow highlight the "vulnerability to price volatility" point? This is important and could be overlooked.	Taken into account.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18040	7	6	37	6	40	Because the term "low-carbon technologies" is not defined (which it should be), the statement becomes very unclear. I suggest splitting the sentence up in 1) renewables; 2) Nuclear; 3) CCS (and other technologies that may be defined as "low carbon"). I would question whether RE technologies can have "substantial" negative impacts (locally, perhaps). Nuclear and CCS are the technologies that can have "substantial" impacts, as stated on 61 which says: "Concerning maximum consequences, those renewable sources clearly outperform all other technologies because their decentralised nature strongly limits their catastrophic impacts".	Rejected - not supported by the broad body of peer reviewed research. The reviewer is reading the term "low-carbon technologies" in a very narrow manner that is not consistent with how the term is applied throughout Chapter 7 or for that matter in previous IPCC assessments. If "low-carbon technologies" includes biomass plantations producing 100 EJ/year then there is literature that speaks to significant ecological concerns that might arise. As written the sentence in question is correct, e.g., this concern can apply to renewable energy technologies as well as CCS and nuclear.
6792	7	6	37	6	38	Saying "many low carbon technologies can have substantial negative ecological impacts " significantly overstates the case. Renewable technologies generally have low impacts. The 2010 US National Academy study on the true cost of the US energy system stated that environmental impacts costs of renewables were assumed low.	Rejected - not supported by the broad body of peer reviewed research. The reviewer is reading the term "low-carbon technologies" in a very narrow manner that is not consistent with how the term is applied throughout Chapter 7 or for that matter in previous IPCC assessments. If "low-carbon technologies" includes biomass plantations producing 100 EJ/year then there is literature that speaks to significant ecological concerns that might arise. As written the sentence in question is correct, e.g., this concern can apply to renewable energy technologies as well as CCS and nuclear.

**Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7**

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10044	7	6	4			CCS high agreement, robust evidence?	Rejected - the reviewer's comment is not supported by the peer reviewed literature. There is a large literature that speaks to the potential for biomass + CCS to create negative emissions. This hasn't been done in practice as there is no disincentive on venting GHG to the atmosphere that is stringent enough to call for measures like this. As more literature were reviewed for the SOD, the confidence level were downgraded in order to reflect deviating voices.
2396	7	6	40	6	41	last sentence makes no sense at all.	Taken into account - text has been deleted.
18176	7	6	40		46	Add to paragraph: Additionally, at high penetration, GHG emissions from low carbon technology can act to limit penetration if a low GHG stabilization target is desired [7.8, high agreement; robust evidence]. Considerable populations do not have access to modern energy resources and technologies, especially in Africa and Asia [7.3, high agreement; robust evidence]. Providing universal access to modern affordable energy services will require understanding of local conditions, and removing of different kind of barriers removing different cultural, institutional and legal barriers, but not necessarily lead to any significant changes in GHG emissions [7.9, high agreement; limited evidence].	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
18177	7	6	40		46	Alternative paragraph: Additionally, at high penetration, GHG emissions from low carbon technology can act to limit penetration if a low GHG stabilization target is desired [7.8, high agreement; robust evidence]. Considerable populations do not have access to modern energy resources and technologies, especially in Africa and Asia [7.3, high agreement; robust evidence]. Providing universal access to modern affordable energy services will require understanding of local conditions, and removing of different kind of barriers removing different cultural, but not necessarily lead to any significant changes in GHG emissions [7.9, high agreement; limited evidence].	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
13285	7	6	40	5	41	It is not clear what this final sentence of the paragraph means - if it means that residual emissions from coal CCS generation might still be too high to be consistent with stringent emissions limits, this could be made clearer (possibly with an example)	Taken into account - text has been deleted.
16773	7	6	40		41	This reference to section 7.8 should be corrected -- reading 7.8 shows there are significant problems insofar as it 1st claims that life-cycle analysis of lower carbon techs could result in increased emissions because of the energy used to make these technologies, but then later in section makes the very good point that as the system lowers its emissions these estimates do not apply. This section seems flawed and inclusion of this point in the summary is not helpful.	Taken into account - text has been deleted. Comment is obsolete. The underlying text in chapter 7.8.1 has been improved.
3772	7	6	40	6	41	Sentence is not clear.	Taken into account- text has been deleted. Comment is obsolete.
5147	7	6	40		41	there is a kind of paradox or bewildering message in this sentence - it states that low carbon technologies are not low carbon - also "Additionally --" points back to the previous sentence , however there is no direct link between "negative ecological impact" and GHG emissions from low carb techs - sentence should be rephrased to clarify message	Taken into account - text has been deleted. Comment is obsolete.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2397	7	6	42	6	46	This needs a more sensitive treatment. It should read sub-Saharan Africa first of all. Second it is not a matter of removing the barriers mentioned alone, that is a small sub set of the issue.	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
2398	7	6	42	6	46	At least one of my published papers in 2010 2011 or 2012 should be cited in the access sections.	Taken into account - references are not shown in the ES. In 7.9.1. the work of Bazilian Morgan is cited.
5132	7	6	42			what are "modern energy resources" ? Should it be "modern energy services"?	Accepted - text revised.
4776	7	6	42	6	46	I don't always agree with this paragraph, as it clearly depends on the choice of the technology. Indeed the cheapest power technology could emit more GHG emissions than other technologies (low- or no-CO2)	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
16774	7	6	42		46	Should qualify the statement that improving access to energy resources does not necessarily lead to changes in emissions -- should use this as opportunity to say "provided such systems rely on lower emitting energy technologies." If these populations are served with older coal technology (as an example) it is very true that emissions could increase significantly.	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
12543	7	6	45			The wording is somewhat misleading. Universal access to affordable low carbon energy resources would "not necessarily lead to any significant changes in GHG emissions," it is true (emphasis added). But it is more likely, and of course more desirable, that the considerable amount of the world's population unserved or poorly served at present gain access to modern affordable low-emission energy services, substituting solar PV and other resources for high-emission high-cost ones (biomass for cooking, diesel, gasoline, bunker fuels, coal) that tend to move down the income ladder as they are displaced by lower-emission resources. While their emissions would increase slightly, that would be greatly outweighed by the emissions reduction from adoption of clean technologies and resources across societies as a whole.	Taken into account - the entire paragraph has been rephrased in order to address concerns of this and other reviewers.
18178	7	6	47		49	Add to paragraph: To increase social acceptance of lowcarbon technologies, a variety of some procedures have been shown to be effective, such as: ensuring a wide distribution of that accurate and unbiased information about the technology, its impacts and benefits, and its interplay with other technologies is widely distributed; aligning the expectations and interests of different stakeholders; adjusting to the local societal context; adopting benefit sharing mechanisms; obtaining explicit support at the local and national levels prior to development; building collaborative networks, and developing mechanisms for articulating conflict and engaging in negotiation.	Taken into account - text revised.
18179	7	6	47		49	Alternative paragraph: To increase social acceptance of lowcarbon technologies, a variety of some procedures have been shown to be effective, such as: ensuring a wide distribution of accurate and unbiased information about the technology, its impacts and benefits, and its interplay with other technologies is widely distributed; aligning the expectations and interests of different stakeholders; adjusting to the local societal context; adopting benefit sharing mechanisms; obtaining explicit support at the local and national levels prior to development; building collaborative networks, and developing mechanisms for articulating conflict and engaging in negotiation.	Taken into account - text revised.
15758	7	6	48			"accurate and unbiased information" is critical but is very often lacking with respect to a fair assessment of renewable energy costs and potential to displace fossil energy	Noted - unfortunately space constraints do not allow to go into all details in the ES.
4804	7	6	5	6	17	Main generation source in South America (developing countries) is hydro which is already a clean technology, thus, mitigation is not needed in the same level as for developed countries where fossil is much more important.	Taken into account - comment is obsolete. Text has been deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4775	7	6	8	6	11	For me "public acceptance" and "economic competitiveness" are included in sustainability concerns. Please be consistent for all AR5.	Taken into account - comment is obsolete. Text has been deleted.
18166	7	6	8		17	Add to paragraph: Factors such as sustainability concerns, public acceptance, systems integration and infrastructure constraints, and economic competitiveness may limit the deployment of individual low carbon options well before technical potential limits are reached. For least developed countries, their dissemination will imply technology transfer and joint development, a massive technology transfer coupled with financial support. In favourable settings, some of the low carbon energy supply technologies are already economically competitive: for example, largescale RE power supplies can be competitive: with fossil fuel alternatives, while smaller scale hydropower, solar photovoltaics, and modern bioenergy systems can sometimes be less expensive than other alternatives to increasing energy access in offgrid, remote and rural areas largescale RE power supplies can be competitive with fossil fuel alternatives, while smaller scale hydropower, photovoltaic and modern bioenergy systems can increase energy access, so as other services, in offgrid, remote and rural areas.	Taken into account - comment is obsolete. Text has been deleted.
18167	7	6	8		17	Alternative paragraph: Factors such as sustainability concerns, public acceptance, systems integration and infrastructure constraints, and economic competitiveness may limit the deployment of individual low carbon options well before technical potential limits are reached. For least developed countries, their dissemination will imply technology transfer and joint development, coupled with financial support. In favourable settings, some of the low carbon energy supply technologies are already economically competitive: for example, largescale RE power supplies can be competitive: largescale RE power supplies can be competitive with fossil fuel alternatives, while smaller scale hydropower, photovoltaic and modern bioenergy systems can increase energy access, so as other services, in offgrid, remote and rural areas.	Taken into account - comment is obsolete. Text has been deleted.
4098	7	6	8	6	9	Shouldn't the issue of intermittency be specifically mentioned here - rather than presumably elided under 'systems integration'? Again it would be appropriate to mention the challenges of low power densities.	Taken into account - intermittency and low power densities are some of the aspects that are part of the integration issues discussed in chapter 7.6. These issues are now summarized in an extended form in the ES. Due to space constraints details, however, are not discussed.
12156	7	6	9	6	9	I think that it's opportune and necessary to include "cultural aspects" in the context of the focused factors.	Taken into account cultural aspects are discussed in chapter 7.9. There is now an extended paragraph on these aspects in the ES.
18498	7	6				The discussion of developing countries (lines 12-13 and 43-45) seems to miss the importance of decoupling growth (including an increase in energy access) and GHG emission increases, whereas mitigation of emissions is more of a priority for developed countries. The discussions of technology transfer and barrier removal would need to fit into that overarching framework.	Rejected - space constraints do not allow to highlight every interesting point.
17887	7	60				please refer to the WHO analysis of the Chernobyl accident as well as Fukushima - consult www.who.int	Taken into account. Please note that there are no formal reports or publications on Fukushima. There is an evaluation of Chernobyl on <a href="http://www.who.int/topics/accidents_radiation/en/">http://www.who.int/topics/accidents_radiation/en/</a>

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
11868	7	60	1	60	3	Again, these studies addressed very particular materials, and I strongly believe that some qualification of the statement is required for example "...in the future could increase the energy cost and..." There are other futures that could be envisioned -for example robust recycling infrastructure due to increased value for critical materials as well as significant reductions in critical material use per unit energy generated (i.e. the kinds of significant reductions we've seen in solar panels and even electronics in terms of material use).	Taken into account: Cite Norgate and Eckelman work
16846	7	60	1		3	If the energy includes the cost of CO2 via a CO2 price, the CO2 in the life cycle should be accounted for.	Taken into account.
17755	7	60	11			delete the words "that is not well represented in the literature" - this is not correct	Accepted. The passage has been added.
12549	7	60	13			A useful reference: Jordan Macknick, Robin Newmark, Garvin Heath, and KC Hallett, 2011. A Review of Operational Water Consumption and Withdrawal Factors for Electricity Generating Technologies. NREL/TP-6A20-50900	Taken into account. This section to be revised based on some of this new data.
10084	7	60	16			Fukushima-Daiichi Block 1 to 4	Accepted
4824	7	60	26	62	24	This section should be subdivided by technology to ease reading and quick comparison of risks by technology	Editorial comment.
11869	7	60	32	61	28	This first paragraph of 7.9.3 seems to be a continuous list of potential accidents from different types of power generation systems. It is, however, incomplete. For example, while coal extraction deaths from collapses and underground explosions are high, the number of miners that die from exposure to coal dust, CO, etc. is probably much larger. Ignoring this but then listing exposure to coal fired power plant pollutants seems like an incongruency. Also, while coal is bad for air quality and consequent emissions in the US (as indicated by the quote in the paragraph), there are many other places, like China, where air pollutants from coal combustion are much worse and likely cause more illness/death. Overall, this section on risk seems like it needs a great deal of refinement, including a plan for how to discuss risks from different fuels/technologies. Further along, in the third paragraph, the list of nuclear accidents comes after what seems to be a summary of risks, and mention of chernobyl and fukushima. This whole section needs reorganization to clarify the desired background information and key points/concepts the authors want to convey. I suspect it could be very much shortened if this was done.	Taken into account. Please note that pollution issues are addressed in section 7.9.2
4821	7	60	34	60	34	Add full stop after "may take place"	Editorial comment.
16849	7	60	36		38	Is this claim of 10,000 deaths substantiated via other studies? It is very controversial and pushed hard by advocacy community -- other high quality citations could strengthen the point.	Accepted. Sentence deleted. These deaths are not due to major accidents.
13205	7	60	37	60	37	This figure of 10 000 coal related deaths is not reflected in figure 7.17	Taken into account. These were not accidental deaths and the sentence has been deleted.
9661	7	60	38			von Hippel et al., 2011 is not in the reference list	Accepted. Sentence deleted.
7743	7	60	4	60	9	Water consumption is also considerably increased by CCS capture plant.	Accepted. Water use added as an issue in the paragraph on CCS.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9281	7	60	4	60	10	This statement seems subjective and unbalanced as it does not seem to attempt to estimate a net benefit-cost position of the application of CCS (i.e. what constitutes an 'environmental burdens' remains vague and undefined. The analytical methodology seems contestable too as there is clearly no attempt to capture either the environmental benefits or a time value (i.e. discounting)). Suggest deleting.	Taken into account. Note that the discussion here is not meant to address the environmental benefits obtained by reducing climate change. However, since a recent analysis looked at just that issue we have added a sentence pointing to this.
2276	7	60	4	60	10	This paragraph on CCS does not mention recent concerns about potential health and environmental effects of from release of amines or amine degradation products ("nitrosamines") from post-combustion capture processes to the ambient, and that these have been addressed excessively in scientific research (summary of references can be found e.g. in the ZEP amine report ( <a href="http://www.zeroemissionsplatform.eu/downloads/985.html">http://www.zeroemissionsplatform.eu/downloads/985.html</a> )).	Reject. The nitrosamines issue is not explicitly mentioned here because the potential magnitude of this impact is smaller than that of other health impacts of these power plants and the fuel production.
16847	7	60	4		8	This seems incorrect or is not coming across clearly – in a world with a CO2 price, if cost are internalized as they are in modeling, CCS still appears as a cost effective mitigation strategy. The points made here are inconsistent with other sections of this document and Chapt 6.	Rejected. This must be based on a misunderstanding. The section is on ecological and health impacts other than those caused by climate change. The sentence clearly states that "the pressures on human health and ecosystems" are increased. This is independent of the CO2 price.
3800	7	60	4	60	8	Please, include as negative impacts of CCS the necessity of further increase in primary energy sources consumption.	Rejected. There is not much space here to deal with ecological and health effect. We hence do not want to add another topic.
13056	7	60	41	60	44	For context, the date of the Shimantan dam failure (1975) should be included at a minimum. Furthermore, a note on substantial improvements in hydropower construction and safety regulations since the 1970s around the world should also be included (similar to what's included for crude oil releases into maritime environments, see p. 62, lines 12-13 in same chapter). As well, China is today considered to be one of the best performers in terms of dam safety, their reputation in this regard is well-supported by the international engineering community. Furthermore, it is IHA's understanding that there was no installed hydropower capacity at these dams at the time of failure, so to assert that hydropower has the highest accident related external costs is a misrepresentation of the facts.	Accepted. Date added.
5175	7	60	41	60	44	the statement lack references. - the statement here is too categorical, it is difficult to see that the logical conclusion from the SRREN is what is stated here. Ref also the text on this in the SRREN SPM	Accepted. The passage has been revised, but we had to shorten it; there is not enough space to treat this as the level of detail of the SRREN.
16130	7	60	44	61	2	The presentation of nuclear risk, in particular the Chernobyl accident, is too controversial. Other estimates such as the TORCH report indicate fatalities in a much higher bracket.	Editorial comment? Please provide correct references if you think we have missed specific publications.
4822	7	60	44	60	44	What about Fukushima?	Taken into account. Please note that the discussion of nuclear risk has been revised.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9604	7	60	45	61	2	<p>Please, rewrite the text, in particular for numbers, with using following information; At this time there are no reliable estimates available of the collective dose due to Fukushima. However, it should be pointed out that estimates of the radioactivity releases from Fukushima show that the releases are low compared to Chernobyl. France's national nuclear regulator IRSN published a comprehensive report in 2012 on the radioactive releases from the Fukushima accident. It found that the releases of radioactive iodine isotopes (of which iodine-131 is one of the most significant in terms of environmental and dosimetric impact) were on the order of a few hundred PBq, which is around ten times lower than the Chernobyl accident [1]. It also found that releases of cesium-137 (which will persist the longest in the environment with its half-life of 30.1 years), were estimated to be 21 PBq, accounting for around one-fourth of the cesium-137 released by the Chernobyl accident [2].</p> <p>[1] IRSN (2012) "Fukushima, one year later: Initial analyses of the accident and its consequences," March 12, 2012, p. 47, lines 22-24.</p> <p>[2] IRSN (2012) "Fukushima, one year later: Initial analyses of the accident and its consequences," March 12, 2012, p. 48, lines 7-10. <a href="http://www.irsn.fr/EN/publications/thematic/fukushima/Pages/overview.aspx">http://www.irsn.fr/EN/publications/thematic/fukushima/Pages/overview.aspx</a></p>	Accepted. The text has been revised. However, we prefer citing peer-reviewed journal papers over agency reports. Thank you for the references in any case
10083	7	60	45	61	2	Please add a reference	Accepted. References have been added.
9476	7	60	46	61	2	<p>Reference source of the estimation about premature death by Chernobyl accident (9,000 to 33,000) should be written.</p> <p>Cardis et al [1] estimated the number of deaths from various cancers caused by radiation from the Chernobyl accident through the year 2065.</p> <p>The study showed that numbers of deaths of all cancers other than leukemia, thyroid and nonmelanoma skin cancers, leukemia and breast cancer are 14,100, 1,650 and 2,100 respectively.</p> <p>[1] E. Cardis et al. (2006) Estimates of the cancer burden in Europe from radioactive fallout from the Chernobyl accident, International Journal of Cancer 119</p>	Accepted. Thank you for the reference!
9510	7	60	46	61	2	<p>There are not enough evidences about " premature death between 9000 to 33000 people ". And this text cause the incorrect imagination of many premature death by Fukushima accident. It should be pointed out that estimates of the radioactivity releases from Fukushima show that the releases are low compared to Chernobyl. France's national nuclear regulator IRSN published a comprehensive report in 2012 on the radioactive releases from the Fukushima accident. It found that the releases of radioactive iodine isotopes (of which iodine-131 is one of the most significant in terms of environmental and dosimetric impact) were on the order of a few hundred PBq, which is around ten times lower than the Chernobyl accident [1]. It also found that releases of cesium-137 (which will persist the longest in the environment with its half-life of 30.1 years), were estimated to be 21 PBq, accounting for around one-fourth of the cesium-137 released by the Chernobyl accident [2].</p> <p>[1] IRSN (2012) "Fukushima, one year later: Initial analyses of the accident and its consequences," March 12, 2012, p. 47, lines 22-24.</p> <p>[2] IRSN (2012) "Fukushima, one year later: Initial analyses of the accident and its consequences," March 12, 2012, p. 48, lines 7-10.(<a href="http://www.irsn.fr/EN/publications/thematic/fukushima/Pages/overview.aspx">http://www.irsn.fr/EN/publications/thematic/fukushima/Pages/overview.aspx</a>)</p>	Accepted. The text has been revised.
6429	7	60	5	60	5	This is typically referred to as an energy "penalty" not "cost"	Editorial. Yes, this is the type of inside jargon we would like to avoid.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4260	7	60	5			Whether or not CCS has adverse effects on human health will also depend on the degree to which it lowers particulate air pollution from fossil fuel combustion. Substantial lowering of fine particulates should more than compensate for any potential adverse effects from leakage of CO2 etc	Taken into account. Reduction of PM precursors due to requirement for gas cleaning in post combustion plants is included in the assessment. However, the comparison basis here are SOTA fossil power systems with modern pollution control equipment.
17940	7	60	9			The cross-reference to Section 7.9.1 appears to be wrong. In general, it would be a good idea to bring the different discussions of CCS impacts across chapters (5, 6, 7, and 11) together.	Action: look for CCS impacts in the other chapters! The reference must now be to section 7.9.3 - order changed.
9606	7	60				Please, import a sentence from line 37 to 41, page 29 in chapter 9 as follows; premature deaths from biomass smoke in households accounted for 1.5 million people in 2008, a number above those from tuberculosis and malaria - that may change little until 2030 according to projections following the present trends.	What is the source of this information?
11949	7	60				This section could be shortened substantially since it relies heavily on a recent IPCC report. Suggest just giving a half page summary with reference.	Rejected. We think the material warrants to be presented in the present, still concise, form
10961	7	60	25	62	24	Confer: Torvanger, Grimstad, Lindeberg, Rive, Rypdal, Bieltvedt Skeie, Fuglestedt, Tollefsen (2012), Quality of geological CO2 storage to avoid jeopardizing climate targets, Climatic Change, 114, 245-260; showing that leakage even under large-scale CCS-based CO2 storage is not likely to have significant effects on future global temperature.	Taken into account. We have chosen not to address CO2 leakage from reservoirs in this section due to space constraints. Thank you for the reference!
4788	7	60	41	60	44	I am surprised of this data that hydro has the highest death rate for all technologies. I can understand that a dam failure may be dangerous. I have in mind a study that compared death to electricity generated (death/TWh) and the highest rate if or coal (technology & death/TWh): coal (world) = 161 ; coal (China) = 278 ; Coal (USA) = 15 ; Oil = 38 ; Solar PV = 0.44 ; Wind = 0.15 ; Hydro = 0.1 ; Hydro (with Banqiao) = 1.4. Please check your figures for all technologies	Rejected. The data summarized here is referenced. No source was given by the reviewer. Not helpful.
10055	7	60	44	61	2	There are several hundred nuclear accidents reported with medium to high environmental impact, including those in fuel supply facilities such as the accident(s) in Majak - e.g. on 29 September 1957. Today the region around Majak / Tscheljabinsk is still among the most radioactively contaminated regions world wide. More references must be added to make complete the information about nuclear accidents of the past.	Rejected. The intention here is not to provide a complete account of the entire past. Given that we want to make informed decisions about future energy systems, it is important to avoid too much focus on practices that are no longer relevant.
9163	7	61		62		Why developed countries only? Many labors are killed by accidents in coal mines in developing countries.	Rhetorical question. Please note that non-OECD countries are presented in the figure.
9164	7	61		62		Show full externalities of the world, not the casualty in the developed countries. Rare metal industries are damaging the local environment in developing countries.	Noted. Why are rare metal industries relevant here? Could you please point us to scientific work in this area?

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5931	7	61		62		It would be important to show the fatalities also in relation to the amount of electricity generated, not only in relation to nominal capacity, by using typical average full -load hours of each technology.	Rejected. The difference due to the load factor would not be apparent given the logarithmic scale of the chart.
16131	7	61	15	61	28	The cumulative operation of 14,500 reactor years should be compared with the initial doctrine of probability of events of one accident with loss of coolant every 100 000 reactor years and one large catastrophic accident for one million years. This means the present doctrine of redundancy and multiple protection is not adequate. This paragraph is strange because it argues on nuclear safety increasing in time, but is based on data (14 500 y.reactors;three catastrophic accidents) contradicting obviously that record.	Rejected. The 100 000 reactor year claim is not relevant here.
9605	7	61	15	61	28	Please, delete here due to redundant, or discuss with the reason why modern nuclear and OECD hydropower plants show the lowest fatality rates.	Taken into account. Please note the section has been shortened.
4112	7	61	15	61	18	As the causes of these three 'nuclear accidents' are indeed 'fundamentally different' it would be worth reviewing the wording here.	Noted. This review comment is unclear, but the wording has been reviewed.
3801	7	61	15	61	28	Too much discussion on nuclear energy compared with other energy sources. This reflects report unbalance.	Rejected. The focus on nuclear in this section is warranted due to the potential for large accident and the dread these carry.
17377	7	61	2			Reliable fatality data...	Accepted. Section revised.
9477	7	61	24	61	28	This part should be left in this report, as it is correct description about efforts to enhance safety of nuclear power.	Taken into account
9511	7	61	24	61	28	Good text. It's very important safety policy of nuclear reactor. This text should be referred to executive summary too.	Taken into account. This is not likely to make it to the summary.
18096	7	61	24	61	28	The distinction between the safety of the oparting plants and the designs that are on the drawing board should be made clearer.	Rejected. As we discuss new designs that are remarkable for their safety features, it should be clear that existing plants do not possess the same features.
16850	7	61	29		32	How good are the statistics for small, highly decentralized systems? How many deaths from installation of rooftop solar and how do these compare with roof install or repair? Are there no health impacts from exposure to toxic materials for workers in factors that produce solar cells? What about exposure to toxic material (resins, bonding agents) for workers in factories that make large wind turbine blades? No reported deaths for workers on very tall wind turbines (I hope these are all minimal, but these systems are new and I wonder if we just haven't gotten around to checking). All the numbers discussed here would be more useful if also put into context of risks or deaths/1000 worker hours or something similar, or perhaps more helpful deaths per unit of energy produced.	Accepted. Please note that we do not make claims regarding smaller accidents. We would very much welcome data sources and studies addressing these issues.
7744	7	61	30	61	32	What renewable sources is the text referring to? Nuclear is not renewable...	Accepted. "those" has been deleted.
18097	7	61	30	61	32	The sentence leaves the impression that "other low carbon technologies" are only more safe because of their "decentralised nature". That leaves much to add, e.g. that they do not use dangerous or polluting elements (fuel, uranium, ...) or extreme temperatures for combustion (and, therefore, explosion hasards); less particles, mercury, water use, riwsk of polution etc.	Rejected. These issues are addressed in section 7.9.2
4823	7	61	5	61	5	Explain maximum consequences index	Rejected - space constraints do not allow to go into the details here.
10056	7	61	15	61	28	see above	Rejected. We do not understand this comment.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4653	7	62		62		Is this table necessary? Could it not be summarized in a short paragraph? In my opinion the whole section on technical risks could be condensed.	Editorial comment
10566	7	62				Bullets on bottom right of figure should become a footnote in caption. Where they are placed now is not easy for the reader to link with the numbers in left hand column	Editorial comment
13206	7	62	1			This figure is misleading and should be checked. It does not reflect the fact that coal is by far the most harmful energy source	Reject. No reference provided to justify the assertion made.
10085	7	62	14		21	There is no mentioning of gas exploration and production accidents like recently in the north sea. In addition there is no remark about the possible contradictions between hydraulic fracturing for shale gas, natural gas or geothermal operations and the storage of CO2.	Reject. No reference provided. Gas accidents are taken into account in Fig. 7.17. We do not understand what the second part of this comment refers to.
15293	7	62	19	63	14	I am surprised to see that hydr fracturing (fracking) is only mentioned as a health & water issue. The 2011 Cornell (Howarth et al.) LCA suggests it is worse than coal, & presumably others have followed us with such analyses. I think such issues should be mentioned, unless the authors feel they don't exist.	Reject. The Howarth study refers to GHG not catastrophic risks and this issue is addressed in section 7.8.1 and 7.5.1.
2974	7	62	25			The cited PSI data has several flaws. By considering only accidents with more than 5 deaths, technologies leading to many but not large accidents like coal mining are heavily underestimated (see: Lirong Wu and others, 'Major Accident Analysis and Prevention of Coal Mines in China from the Year of 1949 to 2009', Mining Science and Technology (China), 21 (2011), 693–699 <doi:10.1016/j.mstc.2011.03.006>.). For fossil fuels in addition an outlook on future risks from new exploration and depletion technologies such as fracking would be useful.	Noted. The reviewer has identified a major gap in the current analysis, i.e. accidents with less than 5 fatalities. No systematic, comparative information of the type presented here is currently available. Thank you for pointing out a relevant reference. The text has been modified to make clear this limit.
11950	7	62	25	64	4	Since this is discussed in other Chapters, a one sentence referral is warranted, not 2 whole pages. This is not on the main topic of Energy Systems	Rejected - we are following the outline dictated by the IPCC, but have reduced the text to less than a page
2843	7	62	25	64	2	The discussion of public acceptability does not cover transmission lines, though these can raise significant acceptability issues.	Accepted - we note in a footnote that transmission is NOT covered here. While a relevant topic, we do not have the space to address it.
9283	7	63				Footnote 18 states "Knowledge about the social acceptability of CCS is limited due to the early state of the technologies' deployment. Recent research has, in part, focused on the need to fully educate respondents about CCS if meaningful insights are to be gained about public acceptance issues".  The extent to which a local community has confidence in the regulatory frameworks that underpin and govern any standard industrial activities (such as CCS, refer to WGIII FOD Chapter 2, page 43 lines 2 - 23 which states that CCS is no more riskier than other fossil fuel applications) often means that the community does not have been "fully" educated on a particular technology for it to have acceptance of its deployment.  The prevailing footnote statement seems to offer quite a subjective statement. I suggest delete it.	Accepted - We have shortened the footnote substantially to address the concern, but still retain it.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
3407	7	63	10	63	13	IPCC SR on CCS already reports these basic ideas. Therefore no need for 7 new references j. Footnote 18 states the obvious and introduces again four references. Similar problems in lines 23-24.	Rejected - these references are from after the CCS special report, and a key purpose of AR5 is to update the literature from previous IPCC reports. While the concepts may not be complicated, a key goal is to point the reader to citations where issues can be addressed in more depth.
16851	7	63	10		12	There are undoubtedly other costs associated with the use of fossil fuels -- however, the fact that CCS tech cost calculations don't include other social costs is not the point is it? The effort is to reduce CO2 emissions while still providing energy. Other social costs can be internalized via market pricing systems independent of climate policies, but if we try to make climate mitigation account for all social ills, do we risk asking it to solve too much.	Rejected - Though we agree with the comment in many respects, this section's purpose is simply to identify concerns related to public perception and acceptance for each of the core energy supply technologies. For all technologies, those concerns extend well beyond carbon, and indeed, some concerns may not even be technically "accurate" in some respects. We agree that carbon policies need not, indeed cannot, address all such impacts, but that argument is not really the aim of this section per se.
9282	7	63	11	63	12	It is not clear what the following statement is actually referring to: "... CCS technologies do not avoid the non-GHG social and environmental impacts of fossil energy sources ..."  The statement would benefit from further information to assist clarity of meaning.	Rejected - we feel that this language is clear. CCS avoids carbon; it does not avoid other social/environmental impacts associated with fossil energy plants.
16859	7	64	15			Where have "new market mechanisms" been defined? I don't know what these are.	Rejected - comment seems to be misplaced. Please clarify where you would like to see this being reflected.
10086	7	64	18		19	This is not only an issue for renewables but large thermal power units as well	Taken into account - comment is obsolete as the underlying text has been deleted due to space constraints.
11870	7	64	18	64	32	The bulleted list provided here seem to be a strange subset of barriers - but the text implies that they are an exhaustive list - perhaps it can be made explicit that this is just a subset or list of examples?	Taken into account - comment is obsolete as the underlying text has been deleted due to space constraints.
5957	7	64	20	24		The inference that the difference between average thermal plant efficiencies and best available is a barrier to mitigation lacks balance. It is an economic consequence of the large scale of the required capital investments and the length of the cost recovery periods. The situation is not a technical barrier. The same argument can be applied to network infrastructure investments	See 7.10.1

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16852	7	64	20		22	Does this really limit mitigation potential? I don't believe this point has been demonstrated -- the discussion of conversion efficiencies and energy penalty of CCS does not seem to understand or take into account how this works in a world with carbon prices. It is also inconsistent with results of most models that look at the energy system --	Taken into account - comment is obsolete as the underlying text has been deleted due to space constraints.
10568	7	64	20	64	22	This is two bullet points	Taken into account - comment is obsolete as the underlying text has been deleted due to space constraints.
9910	7	64	3	64	4	<p>An analysis of 104 empirical studies of innovation to change showed the following barriers, that could refine and structure the discussion of barriers:</p> <p>Issues of resourcing (76%), for instance, "not enough resources" (Post and Altman 1994), "lack of adequate resources such as time and staff" (Adams and McNicholas 2007), limited or no budgeting (e.g. Harris 2000 and Anumba et al. 2006), access to capital and lack of time (Rohdin and Thollander 2006).</p> <p>Issues of capabilities (75%), for instance, "low technology literacy" (Stewart, Mohamed and Marosszeky 2004), "ill-equipped in terms of training and expertise" (Whitaker 1987), "employees are not trained" (Tamimi and Sebastianelli 1998), "lack of understanding" (Waldron 2005), "lack of technical skills" (Rohdin and Thollander 2006), "lack of skill, knowledge and expertise" (Kirkland and Thompson 1999), etc.</p> <p>Issues of communication (64%), for instance, "communication barriers" (Heide, Grønhaug and Johannessen 2002), "communication overload and distortion" (Allen 2002), "lack of communication within the team" (Attaran and Nguyen 1999), "lack of communication among those sharing responsibility for different aspects" (Kunda and Brooks 2000), "poor communication practices that damaged employee commitment to projects" (Jacobs et al. 2006), "tension among departments arising from the incompatibility of actual or desired responses" (Aggarwal 2003), etc.</p> <p>Issues of organizational structure (62%), for instance, bureaucracy (e.g. Molinsky 1999; Borins 2000; Abdul-Hadi, Al-Sudairi and Alqahtani 2005), "salary structure" (Al-Qirim 2007), "complexity, centralization, and formalization" (e.g. Allen 2002), "rigid organizational boundaries" (Butler 2006), "departmental fortresses" (Cicmil 1999), and organizational structure (e.g. Scarbrough and Lannon 1988; McGaughey and Snyder 1994; Yauch and Steudel 2002).</p> <p>Abdul-Hadi, N., Al-Sudairi, A. und Alqahtani, S. (2005): Prioritizing barriers to successful business process re-engineering (BPR) efforts in Saudi Arabian construction industry, In: Construction Management &amp; Economics, Vol. 23, Nr. 3, S. 305-315.</p> <p>Adams, C.A. und McNicholas, P. (2007): Making a difference: Sustainability reporting, accountability and organisational change, In: Accounting, Auditing and Accountability Journal, Vol. 20, Nr. 3, S. 382-402.</p> <p>Aggarwal, N. (2003): Organizational Barriers to Market Orientation, In: Journal of Management Research, Vol. 3, Nr. 2, S. 87-97.</p> <p>Allen, R.Y.W. (2002): Assessing the impediments to organizational change: A view of community policing, In: Journal of Criminal Justice, Vol. 30, Nr. 6, S. 511-517.</p> <p>Al-Qirim, N. (2007): The adoption and diffusion of E-commerce in developing countries: The case of an NGO in Jordan, In: Information Technology for Development, Vol. 13, Nr. 2, S. 107-131.</p> <p>Anumba, C.E.H., et al. (2006): Understanding structural and cultural impediments to ICT system integration: A GIS-based case study, In: Engineering Construction &amp; Architectural Management, Vol. 13, Nr. 6, S. 616-633.</p> <p>Attaran, M. und Nguyen, T.T. (1999): Design and implementation of self-directed process teams, In: Management Decision, Vol. 37, Nr. 7, S. 553-561.</p> <p>Borins, S. (2000): What Border? Public Management Innovation in the United States and Canada, In: Journal of Policy Analysis and Management, Vol. 19, Nr. 1, S. 46-74.</p> <p>Butler, J.C. (2006): Ten Lessons Learned: Data Warehouse Development Project, California Department of Fish and Game. In: CrossTalk: The Journal of Defense Software Engineering, Vol. 19, Nr. 10, S. 16-20.</p>	Rejected - although the information provided by the reviewer is correct, space constraints unfortunately do not allow to go into the details here.
5958	7	64	33			The analysis in Section 7.10.2 should be strengthened as it is a critical aspect of mitigation	Noted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2844	7	64	34	64	38	Should point out that it is not so much the barriers in themselves, as the fact that renewables are thereby less attractive than fossil sources, which leads to a need for policy support.	Noted. The sentence has been deleted to focus more on investments barrier.
18098	7	64	35	64	35	Unclear what is meant by "limits of market capacity". Delete "(ii) Uncertainty of energy prices". The uncertainty of future fuel prices is one of the biggest drivers for zero fuel cost renewables - not a barrier (unless it is wrongly assumed that gas and CCS are low-carbon)	Noted. The sentence has been deleted.
16853	7	64	37			suggest insert after "... among stakeholders" the following: ", vii) absence of a price on CO2 emissions to change the relative competitiveness of low emitting energy systems."	Taken into account. CO2 price is mentioned with energy price.
2845	7	64	39	64	40	Unbalanced – while some studies show lower overall costs, others show higher costs. Should point out that these results depend on assumptions, inter alia about future fossil fuel prices, whose accuracy is inherently unknowable.	Noted. The sentence has been deleted.
6199	7	64	39	64	40	"Various studies indicate that investing in low carbon energy technologies would end up costing less than continuing to invest in older technologies." This sentence, particularly in using the word "would", sounds much more conclusive than may be warranted. It does not say which low-carbon energy technologies would cost less, and thereby clumps together technologies that may be cost-effective with others that are not. It does not describe whether it is referring to overall social costs, or costs that a user would see. Additionally, it needs to tie into reasons why they are not being adopted, and what market failures and/or barriers are maintaining these inefficiencies.	Noted. The sentence has been deleted.
16854	7	64	39		40	This statement is not supported by the literature UNLESS there is a CO2 price on emissions.	Noted. The sentence has been deleted
16856	7	64	39	65	2	This ignores fact that all economic modeling show this change has a cost relative to the no policy scenario. See chapt 6 and 13.	Noted. The sentence has been deleted
9662	7	64	40		41	Be explicit that the new systems would reduce the demand for fossil fuels	Taken into account. This subsection has been revised focusing more on investments. Rephrased.
16855	7	64	40		41	2nd sentence ignores the economic costs created by such a change -- it is not free. Nor does it "save money" -- this does not make it unaffordable, but we should not cross line and claim it is free either.	Noted. Rephrased.
18099	7	64	41	65	2	Important point but somewhat unclear sentence. Is it \$7 bn savings in fuel costs; is it annually, capital expenditure compared to what ?	Taken into account. The paragraph has been revised.
16857	7	64	6			What is definition of "sustainable" energy? Suggest something more precise.	Rejected - comment seems to be misplaced. Please clarify where you would like to see this being reflected.
10567	7	64	6	64	15	Suggest delete - repetitive	Rejected - the reference to the objective serves as an introduction for the entire subchapter of barriers.
13207	7	64	8	64	8	Delete any reference to a specific mitigation objective which is irrelevant in a chapter devoted to the technical constraints in implementing new energy sources	Rejected - the reference to the objective serves as an introduction for the entire subchapter of barriers.
16858	7	64	9		11	Institutions or private investors will not finance projects unless they are confident they can earn a sufficient risk adjusted return -- this includes risk not only from technology, but from particular project, country risks, energy market risks and so on.	Rejected - comment seems to be misplaced. Please clarify where you would like to see this being reflected.
18546	7	64				The sub-sections in 7.10 vary in terms of their treatment of the different technologies (e.g. with some focusing heavily on RE and ignoring other options) and structure, and in some sections strays to topics covered in other sections (e.g. there is a long policy discussion in 7.10.2). Some kind of conformity would be useful - perhaps structuring sub-sections according to the options presented in 7.5, i.e. fuel switching, energy efficiency, ccs, RE and nuclear.	Rejected 7.10 is on barriers and adopting structure along technologies won't work. The focus on RE is justified because the barriers are high for RE.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
3159	7	64	1			Section 7.10 deals with barriers issues that are already discussed, for example, in chapter 3. TSU needs to advise on where barriers should be addressed. Here I repeat a comment I made in chapter 6: "BECCS plays a huge role in the IAMs that can meet goals like 2 degrees. Given that, why not use BECCS as a case study/box in chapter 3 since that would help tie together the issues discussed there with the large role that is assumed for BECCS in some scenarios."	Noted.
11951	7	64	3			Where is economic? And using etc. is very sloppy - makes it seem as is the authors are looking for filler material, when they are already over the limit given by a great deal. And why is physical here in the title since it does not have a section of its own?	Taken into account - economic aspects are discussed in an own chapter (7.8). The things that are mentioned in the title do not necessarily require an own section. The text has been shorted.
4461	7	64		65		This section repeats a number of barriers already discussed, including capital cost investment and uncertainty	Noted. This subsection has been revised focusing more on investments.
3456	7	64	33	64	38	Among the barriers should be mentioned the existence of regulatory barriers to allow consumers to introduce and sell electricity into the electricity grids	Accepted. Rephrased. This subsection has been revised focusing more on investments.
15492	7	64	33	65	32	Financial barriers and investment barriers and opportunities - Quote (even if this point will probably be treated elsewhere, financial solution combining "mix of technologies with special bank condition" (for example the French Zero per cent loan)	Noted.
15493	7	64	33	65	32	Financial barriers and investment barriers and opportunities - Introduce citizen's initiative (such as energy cooperative) to support local investment in RES – wind for example)	Taken into account. Because of space limitation, the suggestion is not explicitly mentioned.
17945	7	64	39	65	8	It is of crucial importance to specify which concepts of cost underlies the claims in this paragraph. Instead of referencing UNFCCC and ADB, the SRREN would provide a much more natural reference with slightly different key messages on the cost side. The numbers of investment in renewable energy are also more recent than the year 2007.	Noted. The sentence has been deleted
2588	7	65	12	65	17	Personally, I strongly believe that the introduction of Feed In tariffs "mechanisms" is a participatory approach for developing renewable energy? Such mechanisms would also increase environment awareness among population	Noted. The paragraph has been deleted.
2846	7	65	12	65	17	This offers only an incomplete checklist. More detailed analysis is needed of the problem of mobilising investment, drawing attention to the scale of the problem, the capital intensiveness and consequent riskiness of low carbon sources, and the uncertainty facing investors and showing how these can be overcome.	Very important comments, but because of the space limitation, a detailed explanation cannot be done.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10002	7	65	12	65	17	<p>This part should be revised to explain that "voluntary target scheme" can be more effective for development of low carbon energy, compared to other mitigation policies such as carbon tax, emission trading, and FIT. 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 No63 line of this table.</p> <p>On the other hand, market-based mechanism such as emission trading has several problems. Volatility of emission permit prices affects volatility of product prices as evidenced by fluctuating price developments in the EU-ETS. Therefore, the market-based policy tools of cap-and-trade cannot provide credible incentives for the technological change, as described in (Montgomery, 2005, abstract) and (Baldrsson, 2009, page29). These literatures are listed in the No62 line of this table.</p> <p>In addition, CO2 leakage caused by the implementation of the ETS happened actually through international transfer of industry, as shown in (Rosendahl, 2011, abstract), (Aichele, 2012, page336), and (Peters, 2011, page1). These literatures are listed in the No50 line of this table.</p>	See 15.5.5 for voluntary scheme.
9374	7	65	12	65	17	Voluntary action policy also plays an important role in implementing low carbon energy system therefore should be added as one of the options.	Taken into account. Added.
18101	7	65	15	65	15	replace "feed-in tariffs" with "support mechanisms" (feed-in tariffs are one of several types, as stated elsewhere).	Noted. The paragraph has been deleted.
16132	7	65	18	65	22	The example of the CDM should be taken with more distance, because too large a share of the mechanism has been allocated to futile or fraudulent cases (i.e. production-destruction of specialty chemicals with N2O "abatement") with a limited share in actual technology transfer with local benefits. A more sober introduction is in order, for example "[The best examples in] the CDM show that such mechanism can work effectively...	Taken into consideration. The paragraph on CDM is deleted. CDM issues are covered in other sections, e.g. Section 4.3.8, Section 7.12 and Section 14.3
15356	7	65	18	65	32	The passage gives the impression of effectiveness of CDM across developing countries however looking at the countries that have benefited from CDM, the statement cannot be made cross cuttingly as e.g. Africa has a very low CDM success rate due to issues related to methodologies, grid emission factors and high transactional costs. These are issues worth highlighting as on line 28 reference to the need for further efforts to alleviate poverty while addressing climate change would better be phrased/captured by indicating need for further "effort and support"	Taken into consideration. The paragraph on CDM is deleted. CDM issues are covered in other sections, e.g. Section 4.3.8, Section 7.12 and Section 14.3
11773	7	65	18	65	22	CDM doesn't necessarily work well. Rosendahl et al. shows that overall leakage typically will be positive and sizeable, thus leading to an overall increase in global GHG emissions when CDM projects are undertaken. These sentences should be deleted. 1. Rosendahl et al.: [Carbon Leakage from the Clean Development Mechanism. Energy Journal], send attachment by another e-mail.	Taken into consideration. The paragraph on CDM is deleted. CDM issues are covered in other sections, e.g. Section 4.3.8, Section 7.12 and Section 14.3
15494	7	65	18	65	22	Delete this part and refer to the forthcoming chapter 7.11.2 GHG pricing policies OR Give figures about geographical repartition and technological repartition. Suggest comparison China with African countries (cross comparison – Geographic-technology). Many reports on this issue (RISOE, UNEP...). Otherwise quote that this part will be completed with a specific chapter later	Taken into account. The part was deleted.
9375	7	65	18	65	22	It should also mention the challenges that CDM mechanism faces such as overconcentration of project types and project host countries. There is also an analysis that overall increase in global GHG emissions with CDM projects undertaking. (Rosendahl, K.E, J.Strand, 2011).	Taken into account. This paragraph is deleted. CDM issues are covered in other sections, e.g. Section 7.12 and Chapter 14.3

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5959	7	65	28	32		It has previously been identified that most RE technologies involve high capital cost. This makes them unattractive to least developed countries. Lack of energy capital stock can only provide an opportunity for low carbon investments if extensive external support mechanisms are put in place	Noted.
16860	7	65	35			Climate policy does not mean the energy system must be or should be renewable energy sources only -- rather, economic modeling suggest that the lowest costs approach is focused on low emitting energy technologies. Renewables only is possible, but incurs much higher costs than a system that is open to other technologies. See chapter 6.	Taken into consideration. We are saying large penetration of RE and NOT ONLY RES. We included low emitting energy technologies after checking with chapter 6
10087	7	65	7		8	2011 Figures are \$ 263 billion . A regular update is encouraged. (source: BNEF)	Accepted. Updated.
18100	7	65	9	65	11	Delete paragraph. Onshore wind cannot be considered "high risk". Offshore wind perhaps, as well as coal or gas with CCS, nuclear, ocean energy, solar thermal.	Noted. The paragraph has been deleted.
10057	7	65	1	65	11	outdated sources, newer publications are available such as Global Renewable Status Report 2012 /REN 21	Noted. The paragraph has been deleted.
17946	7	65	11			It is not clear what 'early stages' is supposed to mean here. If this is targeted at the stage of innovation, the reference would need to be more recent than 2009, since wind energy technology is rapidly maturing.	Taken into account. The sentence is deleted.
17947	7	65	12	65	17	The policy recommendations provided here rather belong to the policy section and do not constitute a comprehensive assessment of various policy options.	Deleted.
15066	7	65	18	65	22	Many literatures have found that substantial share of the CDM projects actually do not have "additionality". See, for example, L.Schneider (2009), "Assessing the additionality of CDM projects: practical experiences and lessons learned", Climate Policy, 9(3) pp.242–254; S. Ferrey (2011), "Can the CDM catalyze renewable energy?" in Mehling et al. (eds), Improving the Clean Development Mechanism: Options and Challenges Post-2012, LEXION, Berlin; M. Bogner and L. Schneider (2011), "Is the CDM changing investment trends in developing countries or crediting Business-as-Usual?: A case study on the power sector in China, in Mehling et al. (eds), Improving the Clean Development Mechanism: Options and Challenges Post-2012, LEXION, Berlin; J. Zhang and C. Wang(2012). "Co-benefits and additionality of the clean development mechanism: An empirical analysis", Journal of Environmental Economics and Management, Vol.62, pp.140–154. Therefore, in my view, it is not appropriate to conclude immediately that CDM has worked effectively to deploy low carbon energy technologies in the developing countries as stated in the present text. It is really no matter how many tons of CO2 have been issued as CERs, since they are likely to be just "Business-as-usual" of GHG reductions if they are non-additional projects found by the above literatures.	Taken into consideration. The paragraph on CDM is deleted. CDM issues are covered in other sections, e.g. Section 4.3.8, Section 7.12 and Section 14.3
17948	7	65	28	65	29	This sentence should provide a cross-reference to Chapter 4 that is supposed to frame all SD discussions in WGIII AR5.	Taken into account. The sentence has been deleted.
6552	7	65	7		8	Firstly, "148.4 billion" instead of "184.4 billion" is correct. Secondly, add a conditional clause to "more investments are required to stabilize climate change", as the Stern Review, cited by UNEP (2008a), only gives the cost for stabilizing at 550 ppm CO2-eq.	Taken into consideration. Rephrased. Data is updated.
3457	7	65	34	66	37	Among the barriers mentioned, it should be included those regarding behavioural change on rational use of energy in developing countries as well as it should be mentioned the need to change high energy consumption style of life in countries like USA	Accepted. Behavioural aspects in high consumption countries is included
15495	7	66	10	66	11	Delete « not because they are a poor alternative to fossil fuels » as this is simply not true.	Taken into account. The focus of the perception is the lack of understanding why the technologies may be needed and not really on comparing various options.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
15496	7	66	15			Not sure to get the good understanding of "free access" explanation - Rewording may be necessary?	Accepted. Rewording is done: "For instance cooking fuels particularly firewood is widely used in rural areas because it is a suitable fuel for these communities in addition to its access without payment apart from the time devoted to its collection."
16862	7	66	18		24	Suggest delete. The policy in question is concerned with climate and CO2 emissions. Sustainability is not well defined or broadly understood.	Accepted. suggest to delete line 18 to avoid further text on definition of institutional sustainability
17378	7	66	22			and implementation of energy policies	Noted
16861	7	66	8		12	This sounds like a stereotype and patronizing. It may also be they simply want reliable energy and may not be convinced of the reliability or durability of these new systems. It may also be that they think these systems are more costly, or that it is easier to find technicians or parts when systems fail if they have older, more conventional technology.	Accepted. These considerations were included.
10003	7	66	8	66	12	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, as described in (DeCarolis, 2006, page 395 and 403). This literature is listed in the No26 line of this table.	Taken into consideration. The whole paragraph need to be reconsidered. Need to find better argument
17949	7	66	1	66	7	These claims would need to be substantiated by references; I recommend to cross-reference to the discussions in the SRREN where these issues were assessed at length in chapters 8 and 9 and the assessed references therein.	Accepted. Chapter 8 and 9 are considered
17950	7	66	13	66	24	Again, these results would need to be substantiated by references, e.g. SRREN chapters 9 and 11 and the assessed references therein.	Accepted.
10058	7	66	38	67	26	outdated sources, newer publications are available such as Global Renewable Status Report 2012 /REN 21 and Energy [R]evolution June 2012	Rejected. Sources are not outdated. However lines 18-24 are modified after checking with new publications.

**Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7**

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9478	7	67	10	67	14	<p>When employment effects of renewable energy is considered, not only direct effects of the renewable investment, but also broad and long effects on the economy should be counted.</p> <p>Hillebrand et al. published a study about the renewable energies' expansion beginning in 2004 and employment effects in Germany [1]. They note that they distinguish two effects: (1) an expansive effect resulting from additional investments and (2) a contractive effect resulting from an increase in the production cost of power. The first effect will dominate during the first years and lead to an increase in employment of approximately 33,000 new jobs. However, the contractive effect will offset these gains and lead to a slightly negative employment balance by 2010.</p> <p>[1] B. Hillebrand et al. (2006) The expansion of renewable energies and employment effects in Germany, Energy Policy 34, [1] page 3484, Abstract lines 5-8.</p>	<p>Taken into consideration. Most of the comments to this section are focused around the issue of the net employment benefits of investment in RES systems. I agree that there are both positive (direct) and negative (indirect) employment effects. Although, in absolute terms, the number of jobs created by RES may not be that high, the direct employment effects associated to renewable energy deployment is the most significant contribution to local sustainability and the need for human capacity development is there, which is the central message of this section. Nevertheless, references were added that report both net positive and net negative employment effects.</p>
10089	7	67	10			<p>Employment in 2011 in the RE sector was estimated at 5 million jobs (REN21 2012)</p> <p>A sentence like: "Employment more than doubled from 2.3 million in 2006 to 5 million in 2011" could be added.</p>	<p>Accepted. Good suggestion as it would be helpful to show the trend</p>
10004	7	67	10	67	14	<p>This part should include 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).</p> <p>&lt;Reference&gt;                      [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.</p>	<p>Taken into consideration. Most of the comments to this section are focused around the issue of the net employment benefits of investment in RES systems. I agree that there are both positive (direct) and negative (indirect) employment effects. Although, in absolute terms, the number of jobs created by RES may not be that high, the direct employment effects associated to renewable energy deployment is the most significant contribution to local sustainability and the need for human capacity development is there, which is the central message of this section. Nevertheless, references were added that report both net positive and net negative employment effects.</p>

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9608	7	67	12	67	14	<p>Please, discuss here from a positive and a negative side by using following information: many of the claims regarding the positive employment effects of renewable energy introduction only count the direct effects of the renewable investment, without taking into account the broader effects on the economy as a whole. Several studies have indicated that the creation of "green jobs" leads to destruction of jobs in other sectors of the economy. For example, in a peer-reviewed study on the economic impacts of renewable expansion beginning in 2004 in Germany (Europe's largest economy) Hillebrand et al. found that [1] there are two effects: (1) an expansive effect resulting from additional investments and (2) a contractive effect resulting from an increase in the production cost of power. The first effect will dominate during the first years and lead to an increase in employment of approximately 33,000 new jobs. However, the contractive effect will offset these gains and lead to a slightly negative employment balance by 2010.</p> <p>[1] B. Hillebrand et al. (2006) The expansion of renewable energies and employment effects in Germany, Energy Policy 34, See downloaded file "Hillebrand Buttermann 2006.pdf"</p>	<p>Taken into consideration. Most of the comments to this section are focused around the issue of the net employment benefits of investment in RES systems. I agree that there are both positive (direct) and negative (indirect) employment effects. Although, in absolute terms, the number of jobs created by RES may not be that high, the direct employment effects associated to renewable energy deployment is the most significant contribution to local sustainability and the need for human capacity development is there, which is the central message of this section. Nevertheless, references were added that report both net positive and net negative employment effects.</p>
16864	7	67	21		26	<p>The issue of lack of human capital or skilled labor is true for non-climate policies as well. This problem is not unique to climate mitigation -- highlighting it in the context of this document makes the climate task seem even harder. I believe it is not helpful to policymakers. Those who will deploy the tech will deal with this problem at the proper time.</p>	<p>Taken into consideration. I agree that this issue is not unique to climate mitigation and that a well functioning market should help correct any imbalance over time. In the US there is a TV program on the "Weather Channel" that is about how the wind industry is growing so fast that people from other industries are being trained to construct and perform maintained on wind turbines. It seems like that's the way the world works.</p>
10090	7	67	28		35	<p>To stop in 2009 is misleading because the rapid development of RES power generating capacities over the last years is neglected. Power market share of renewables from 2000 to 2010 including Hydro was 26% [Greenpeace Energy [r]evolution, 4th edition 2012 world energy scenario]. In 2010 and 2011 almost 50% and 40% respectively of new power capacities were renewable, increasing the renewable capacities to 1,360 GW (390 GW without Hydro) at the end of 2011 [Ren21 2012]. In addition, the figures for retired high carbon power plant capacities should be given as well.</p> <p>The conclusion could be that despite the fact that there is still massive investments in high carbon stock, the situation is changing gradually and there is a huge potential for low carbon technologies replacing the 1,266 GW of fossil capacity which is scheduled to retire in the next 25 years [IEA 2011a].</p>	<p>Taken into account - the latest year available (2010) for recent investments has been updated and discussed. However it is extremely problematic to get data on retired power plant, which is further complicated given many old plants are mothballed for possible restart.</p>

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5960	7	67	29			Clarity: there is greater certainty regarding effective carbon lock-in than is stated	Taken into Account - the effectiveness of lock-in due to energy investments has been more fully discussed.
18222	7	67	30			Of the 1327GW investments (from 2000-2009) in the global electricity sector (SJ Davis et al., 2010), 416GW (31.4%) were coal, 449GW(33.9%) were natural gas and 47GW (3.6%) were oil. Construction of renewable source power plants together accounted for 231GW (17.4%), with nuclear at only 29GW (2.2%). Therefore high carbon energy capital stock is currently being heavily invested in and will be still in place for decades to come. Comment: From 2000 to 2009 it invested more in coal plants by developed countries, which contradicts the obligations and commitments. It is suggested to be penalized by moratoriums conventional coal plants in order to be controlled. Alternative paragraph: Of the 1327GW investments (from 2000-2009) in the global electricity sector (SJ Davis et al., 2010), 416GW (31.4%) were coal, 449GW(33.9%) were natural gas and 47GW (3.6%) were oil. Construction of renewable source power plants together accounted for 231GW (17.4%), with nuclear at only 29GW (2.2%). Therefore high carbon energy capital stock is currently being heavily invested in and will be still in place for decades to come.	Noted - Supports the above approach on making the developed vs. developing country energy mix and investments more explicit, and on updating data to 2010
7745	7	67	32	67	33	Please, correct the sentence in order to avoid a misunderstanding. Currently, it gives the false impression that nuclear is renewable.	Taken into account - the language has been edited to avoid this potential misunderstanding
3803	7	67	33	67	33	Too much polarization on nuclear energy.	Rejected - no specific recommendation, and the text is simply listing the actual investments in various technology types.
3011	7	67	33			The sentence "Construction of renewable source power plants together accounted for 231GW (17.4%), with nuclear at only 29GW (2.2%)" gives the wrong idea that nuclear is a renewable source.	Taken into Account - the text has been checked to avoid any potential misunderstanding between categories of nuclear and renewable
16865	7	67	41		43	When discussing building stock and urban infrastructure, the lock in is less true of the underlying energy system employs technologies that emit little CO2. For example, if a road is built and vehicles use electricity from non-emitting technologies, then the road has no lock in problem.	Accepted - text has been revised to make clear the importance of the underlying energy technology mix (including the developed vs. developing county distinction in installed energy)
11774	7	67	6	67	14	To avoid too much expectation to the renewable energy, number of jobs to be lost instead should be also added. there aren't appropriate paper, this sentence should be deleted. It is easy to guess that PV field only produces temporary jobs for construction because it is basically maintainance free once installed. Furthermore, Hillebrand et al. shows the creation of "green jobs" leads to destruction of jobs in other sectors of the economy in German case study. 1.B. Hillebrand et al.: [The expansion of renewable energies and employment effects in Germany, Energy Policy 34], send attachment by another e-mail.	Accepted. There are also more recent peer reviewed literature than that of Hillerbrand that show net positive employment effects as well.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9663	7	67	6		14	No mention is made of the capacity building, employment etc in the fossil fuel industries. A comparison between the industries should be given. How many jobs etc would be lost with the downscaling of the fossil fuel industry in relation to the opportunities provided by the RE industry?	Taken into consideration. A balanced treatment of employment in fossil fuel industries and RE industries is attempted. The new paragraph says: "Renewable energy has a high potential for direct employment generation, including R&D, engineering, consultancy, auditing, quality control, and installation and maintenance. 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). In developing economies, particularly in a rural setting, energy access through RE deployment can generate significant employment (Openshaw, 2010; IRENA, 2012), and shortages of teachers and trainers in subjects related to the fast-growing renewable energy sector have been reported (Strietska-Iliina et al., 2011)."
10088	7	67	6			insert "local" in front of employment	Noted
2847	7	67	6			Should also mention that the employment benefits have been disputed – eg Hillebrand et al Energy Policy Vol 34 issue 18 p 3484-94 for Germany; <a href="http://www.juandemariana.org/pdf/090327-employment-public-aid-renewable.pdf">http://www.juandemariana.org/pdf/090327-employment-public-aid-renewable.pdf</a> for Spain. Again the authors may not agree with these studies but balance requires that they acknowledge them.	Accepted, in similar vein to line 105, 107-109
16863	7	67	6		20	If you replace renewable section with "low CO2 emitting technologies" you would be able to shorten this section.	Noted

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10663	7	67	6	67	14	It should be shown to what type of energy renewable energy potential for employment is better. There is the case a number of jobs lost because of the too much subsidies. See " Study of the effects on employment of public aid to renewable energy sources" by Calzada et al.	Taken into consideration. Most of the comments to this section are focused around the issue of the net employment benefits of investment in RES systems. I agree that there are both positive (direct) and negative (indirect) employment effects. Although, in absolute terms, the number of jobs created by RES may not be that high, the direct employment effects associated to renewable energy deployment is the most significant contribution to local sustainability and the need for human capacity development is there, which is the central message of this section. Nevertheless, references were added that report both net positive and net negative employment effects.
4654	7	67	6	67	11	"RE has a high potential for employment generation ---". Line 10/11 "Globally, it is estimated that in 2006 more than 2.3 million people were employed in the RE sector; about half of which in biomass ---". Not only does RE have a high potential for employment generation it already does. The employment in existing fuelwood, charcoal and residue trading has been completely ignored. From my work in various countries, especially Malawi, I estimated that about 30 million people are employed (full time equivalent and many more part-time) in growing, production, transport and trade of biomass energy, of which about 77% are rurally based. (Openshaw, K. 2010a). If poverty alleviation is a goal, then this should be encouraged.	Accepted. Will be included to the additional references that will be cited as mentioned in line 105.
3802	7	67	7	67	7	Replace "auditing" by "auditing".	Noted
3458	7	67	15	67	26	It should be included some lines regarding the need of capacity building in energy planning and mitigation assessment	Accepted. The suggestion is useful
15132	7	67	6	67	6	The findings indicate that energy access through renewable energy technologies can generate significant employment: reaching the objective of sustainable energy for all could create almost 4 million direct jobs by 2030 in the off-grid electricity sector alone. 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. Importantly, this limits the need for developing countries to rely on foreign know-how and expertise. However, the case studies show that, in addition to formal or full-time employment, entrepreneurs in remote rural areas often take on labourers in highly informal arrangements in order to retain the flexibility needed for what are often fluctuating and uncertain business circumstances. IRENA, Renewable Energy Jobs & Access, 2012	Taken into consideration. However, the IRENA 'Jobs & Access' document is not peer-reviewed

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17952	7	67	41			The following paper might be interesting in this context: Steven J. Davis, Ken Caldeira, and H. Damon Matthews (2010) Future CO2 Emissions and Climate Change from Existing Energy Infrastructure. Science 329: 1330-1333	Taken into Account - this is a fair comment as the lock-in is to a class of technology or infrastructure or pattern of behaviour, rather than to a very specific technology. The suggested paper is cited.
12330	7	67	27			This is an important issue (lock-in) . It should also be covered in the Executive Summary of Chapter 7 and be considered for the SPM.	Rejected - the ES is reserved for central statements. The inertia is important, but other topics are much more important.
4655	7	68		68		Many (rural) houses in developing countries have lifetimes much less than 50 years.	Taken into account - the table with this data has been removed for reasons of space and the text discussion does not have this specific example
9166	7	68		72		this section has to be shortened, focus on what are specific to this sector, and refer to ch13-16.	Taken into account - the description of the instruments and their economic justification is left to the policy chapter (13- 15).
4825	7	68	13	68	13	The author of the paper cited here is DECC (Department of Energy and Climate Change) not Ofgem	Accepted - text revised.
9664	7	68	19		25	this text is unnecessary	Taken into account - There is a duplication with respect to page 68 (lines 13 - 18) and page 68 (lines 19 - 27). As the comment 1767 suggests the first paragraph is deleted. The other paragraph however stays.
18102	7	68	23	68	23	Replace "(e.g. Feed-in tariffs or renewable energy quotas)" with "(e.g. price or quantity based mechanisms)" in order to capture, for example premium systems.	Accepted - The text is revised, and the reference is updated.
3804	7	68	32	68	34	This sentence is in conflict with the target of reaching peak GHG emissions by 2020. I understand that RN Scheck et al is referring to new/or improved technologies beyond the ones that are already available. Otherwise, we are conflicting with earlier IPCC reports where technology is mentioned as not being the main barrier to curb GHG emissions, but lack and enforcement of energy policies are.	Taken into account - the text of the paragraph has been deleted as a result of suggestions to restructure the entire section.
4462	7	68		72		This section offers a lengthy discussion of policies and challenges. The section could be shortened by offering a description of the policies which have worked (broadly) and those which have not, with a discussion of the conditions for success and failure, respectively. The goal of this section is to offer the reader guidance on policy design and considerations, with insights into what policies have worked and how to avoid those which have not.	Taken into account - the entire section has been rewritten in order to facilitate an assessment of the different energy policies. However, due to space restriction, some of the issues mentioned here are discussed in more detail in chapters 13 -15.
18547	7	68				Please make sure that this section follows the categorization for policies outlined in Chapter 3.	The order of the section now follows the Vigo Accord.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18548	7	68				This section has a very clear description of policy mechanisms and how they relate to and address market failures. However, a lot of this is already covered in the policy chapters. As such, the section could be shortened to focus more strictly on energy - ideally linking more directly to the energy options outlined in the AR4 and in Section 7.12 of this chapter on p. 85, fuel switching, ee, RE and CCS.	Taken into account - the description of the instruments and their economic justification is left to the policy chapter (13- 15).
3160	7	68	10			section 7.11 deals with policy choice, but those issues are addressed in many places in the WG3. I suggest TSU advise on how to consolidate.	Taken into account - the description of the instruments and their economic justification is left to the policy chapter (13- 15).
11952	7	68	14			"nature of instruments" is very vague. What is actually discussed in 7.11.1 is RD&D investments. In truth the following paragraph is a better description. Suggest dropping this paragraph.	Taken into account - text revised.
13219	7	68	28	69	24	The discussion that is not specific for the power sector could perhaps be integrated in chapter 15.6, and the focus of this section be dedicated on the aspects RD&D policies specific to the power sector. In particular (i) public and private actors have similar level of information and similar priorities about the overall needs for technology thus facilitating a public policy (ii) more homogeneous nature of product limits the ability to price discriminate and charge premium for new technologies (see e.g. 44. Neuhoff, K., 2005, Large-scale deployment of renewables for electricity generation, Oxford Review of Economic Policy, 21 (1), p. 88-110).	Taken into account - the description of the instruments and their economic justification is left to the policy chapter (13- 15).
6553	7	68	31		32	Give a reference paper for the description "carbon emissions to ultimately peak and decline toward zero for any stabilization concentration".	Taken into account - the text of the paragraph has been deleted as a result of suggestions to restructure the entire section.
14546	7	69	1	69	7	This is a very insightful paragraph. We have an opportunity to use the Green Climate Fund for the public good. A significant portion should be devoted to R&D to transform RE technologies that are not yet economically viable into viable one, instead of being divided up among many countries for small projects.	Taken into account - the text of the paragraph has been deleted as a result of suggestions to restructure the entire section.
9609	7	69	11	69	15	Please, check figure 1.1 as the reference of Tracking Clean Energy Progress as the trend of graph starts to increase from 1999, not the release of AR4. Of importance is global public energy sector RD&D spending remains a small share of total RD&D budgets and spending levels have seen a recent decrease from peak spending in 2009. (IEA, 2012b p.13)	Accepted - text revised.
10091	7	69	16		18	The Battelle Institute publishes annually the Global R&D Funding Forecast (2012: <a href="http://www.battelle.org/aboutus/rd/2012.pdf">http://www.battelle.org/aboutus/rd/2012.pdf</a> ). 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 spending on energy R&D is forecasted to increase by roughly 10% from \$ 15 billion in 2010 to \$ 17.9 billion in 2012.	Noted - the comment confirms the assessment that private R&D expenditures are a large share of the overall R&D spending.
18103	7	69	21	69	24	Delete paragraph. This holds for all technologies that have reached commercialisation. Alternatively add "nuclear, coal and gas" which have received (and still does) far higher government R&D funding than PV and wind or other renewables.	Accepted - text revised.
5937	7	69	25			It is peculiar not to mention the practical drawbacks of tax policies to price GHG emissions, while discussing EP extensively. To name one obvious drawback, taxes are often set in annual budgets, which introduces a very clear political risk.	Taken into account - The comment is obsolete as the underlying text has been deleted.
9610	7	69	26	70	8	Please, move here to somewhere in chapter 13 to 15 as this part consists of general idea of pricing policy.	Taken into account. The first paragraph has been removed as suggested. The second paragraph is related to the energy systems. It therefore belongs to the section.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6200	7	69	30	69	34	"Tax regimes fix the tax rate and allow markets to determine emissions, while EP regimes fix emissions and allow markets to determine the EP price. In a world with certainty it is a matter of indifference which approach is taken as both can be implemented so as to deliver the same distribution of economic activities in the economy. However, the two policy instruments differ importantly in their implications for income distribution." the first two sentences are important points, highlighting the concept that the two approaches can be designed to achieve the same effect in a world of certainty. However, the third sentence discusses differences, suggesting that these differences are inherent. Both cannot be true at the same time. the differences in income distribution need not be inherent, but arise from choices in implementation, specifically whether and how permits are freely distributed.	Taken into account. The comment is obsolete as the underlying text has been deleted.
15545	7	69	41			As well as Weitzman, Pizer has written key articles on this issue e.g. Pizer, WA (2002). 'Combining price and quantity controls to mitigate global climate change,' Journal of Public Economics, Vol 85, pages 409–434; Pizer, WA (1997). 'Prices vs. Quantities Revisited: The Case of Climate Change' Discussion Paper 98-02, Resources for the Future, Washington DC. W. Nordhaus and G. Metcalf have also written extensively on the advantages of taxes over cap and trade. A different view is reflected in the Stern Review (2007).	Taken into account. The comment is obsolete as the underlying text has been deleted.
15480	7	69	41	69	42	The citation to Weitzman is too absolute - the 1974 paper showed that the balance of advantage depends on the relative slope of the marginal damage and the marginal cost of abatement - subsequent papers summarised in Hepburn (2009) in Eds Helm and Hepburn "The Economics and Politics of Climate Change" OUP show that this will normally imply taxes are the best choice for carbon, but Hepburn points out that this is NOT inevitable. Weitzman 2007 is irrelevant here.	Taken into account. The comment is obsolete as the underlying text has been deleted.
15544	7	69	25			Should this discussion be here or in Ch 15, on Policy Instruments? Is there a danger of repetition?	Taken into account. The text has been deleted as it refers to general aspects of policies which are discussed in Chapter 15.
13220	7	69	25	72	11	A closer coordination with chapter 15 section 5.4 could help to reduce overall length of report. (Have not been involved in discussions, so not clear what arguments for discussion of CDM in chapter 7 rather than 15.).	Taken into account -overlaps between this section and chapter 15 - 17 has been removed as far as possible and appropriate.
15497	7	69	25	72	8	GHG pricing policies – Too long – Recommend to create at least 3 sub chapters – (1) General items & (2) ETS and others trading schemes & (3) Flexible mechanisms and NMM New Markets Mechanisms	Taken into account - The text has been reduced and structured as suggested
15498	7	69	25	72	8	Add a special item somewhere on NAMA, NMM and MRV requirements	Rejected- space restrictions do not allow for these extensions. The related instruments are discussed in chapter 15.
2848	7	69	26	72	8	This section is longer and more theoretical than needed and it overstates the impact of carbon trading – see below.	Taken into account - The section has been shortened. The impact of carbon trading now is discussed in more detail.
10955	7	69	41	69	42	Imprecise; depends on type of uncertainty. Weitzman (1974) shows that tax is best choice if mitigation cost uncertainty is more important than uncertainty w.r.t. impacts of human-induced climate change.	Taken into account. The comment is obsolete as the underlying text has been deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4777	7	7	1	7	8	I support this statement. On request I can provide a box explaining the hydropower sustainable assessment protocol, published by IHA, and developed with NGOs, Governments, Banks, utilities, etc.	Noted - unfortunately space constraints do not allow for a detailed discussion of single examples.
2940	7	7	11	7	16	It is good to see these key conclusions so strongly expressed. I agree strongly that the evidence is strong that "Transition to low GHG concentrations will NOT be achieved by current energy investments nor simple evolution of business-as-usual..." and that "Strong policy support of low carbon energy supply options will be necessary to achieve this goal , [which requires] energy-related GHG emissions to peak by 2020".	Noted.
13035	7	7	12	7	12	suggest adding the word "levels" after the phrase "current energy investments" so that the sentence reads: "Transition to low GHG concentrations will not be achieved by current energy investment levels nor simple evolution of business-as-usual of energy supply systems." Without this, the sentence implies that current investments in specific projects will have no impact.	Taken into account - comment is obsolete as the underlying text has been deleted.
17204	7	7	13			The lock-in of emissions is ignoring the possibility of early retirement of existing capital stocks. This is an economically meaningful option that is realized if CO2 prices increase the variable costs so that the continuation of the operation of the plant makes losses. So far, there are no publications on the issue, but they are in the making.	Taken into account - comment is obsolete as the underlying text has been deleted.
15541	7	7	13		14	This depends on scrapping and depreciation rates, which are not purely technologically determined.	Taken into account - comment is obsolete as the underlying text has been deleted.
6794	7	7	13	7	15	"Existing energy-related capital stock has already locked in 80% of the permissible 2035 CO2 emissions under a 450ppm CO2eq stabilization scenarios [7.12, high agreement; robust evidence]." I have two concerns with this. First, capital stock should not be considered "locked in." The cost of replacing this stock is less than the cost of addressing the climate change damage resulting from it. When we finally enact carbon pricing, the cost of coal electricity will go up. US utilities have already idled coal plants to operate cheaper natural gas plants. We can't afford to "lock in" climate change damage. Second, there is little scientific evidence that stabilization at 450 ppm will prevent unacceptable consequences. It is more likely that we will need to eventually reduce atmospheric CO2 to lower levels. (James Hansen's 350 target is more scientifically defensible, in my opinion.) The IPCC goals should be re-evaluated in light of the latest scientific results based on measurements, model results, and paleoclimate studies. The goals should be based on science and not based on what is (or was) believed to be politically and socially achievable. I realize this is a Working Group I decision, but I think it is entirely appropriate for members of Working Group III to advocate for a more scientifically-based goal, because that goal has an enormous impact on the solution strategy, both in terms of its content and the required speed of implementation.	Taken into account - the first comment is obsolete as the underlying text has been deleted. The second comment on the rationale behind the 450 ppm stabilization level is outside of the scope of WGIII. It is to be inferred by considerations that have to come from IPCC WG I and IPCC WG II. WG III does not advocate for any stabilization level. It simply investigates the implication of some of these levels. As statements of the IPCC have to be policy relevant (but not prescriptive), the 450 ppm level which is broadly consistent with the Cancun Agreement is investigated in more detail as it is the currently legally binding goal of the parties to the UNFCCC.
6223	7	7	13	7	15	This does not take into account the possibility of retrofitting CCS	Taken into account - comment is obsolete as the underlying text has been deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18180	7	7	15		20	Comment: Strong policy support of low-carbon energy supply options will be necessary to achieve this goal requiring energy related GHG emissions to peak already by 2020 [7.12, high agreement; robust evidence]. Energy policies consistent with ambitious longterm greenhouse gas concentration levels, such as are described in Chapter 6, are not observed in most of the world at present, though governments have pledged to reduce emissions in line with the Copenhagen Accord [7.3. and 7.12, high agreement; robust evidence]. Comment: Again the Copenhagen accord is referenced as if it were a formal and official document of the UNFCCC, and the Bolivarian Republic of Venezuela expressed herein public rejection. COP-15 took notes of this document.	Taken into account - Copenhagen Accord is replaced by Cancun Agreement.
18181	7	7	15		20	Alternative paragraph: Strong policy support of lowcarbon energy supply options will be necessary to achieve this goal requiring energy related GHG emissions to peak already by 2020 [7.12, high agreement; robust evidence]. Energy policies consistent with ambitious longterm greenhouse gas concentration levels, such as are described in Chapter 6.	Taken into account - Copenhagen Accord is replaced by Cancun Agreement.
6545	7	7	15		16	Replace "will be necessary to achieve this goal requiring" with e.g. "will be necessary if this goal is to be achieved, which requires", as "this goal" has not been agreed on globally.	Taken into account - although the Cancun Agreement is legally binding the statement has been rephrased in order to emphasize that it is an "if ... then" statement.
7725	7	7	17	7	20	Suggest replace "Copenhagen Accord" by "Kyoto Protocol".	Rejected - what is meant is the 2°C goal. The Copenhagen Accord is replaced by the Cancun Agreement.
7851	7	7	19	7	20	The statement that governments have pledged to reduce emissions in line with the Copenhagen Accord is ambiguous and lacks clarity because the pledges do not match with the 2 degrees goal agreed in Copenhagen. A more appropriate language would be to say: ..., though governments have pledged to reduce emissions as part of the Copenhagen Accord. It is suggested to add: However, those pledges fall short to meet the 2 degrees goal and might result in a temperature increase above 3 degrees C.	Taken into account - text has been deleted. Comment is obsolete.
15759	7	7	2			what are "benefit sharing mechanisms"?	Noted - benefit sharing provides money to those who are affected by additional power plants or power lines.
5941	7	7	20			The Summary should note, as per Chapter 7.12 and otyher studies (EURELECTRIC (2009), Power Choices: Pathways to a Carbon Neutral Electricity in Europe by 2050. Avaiable at www.eurelectric.org ) the decarbonisation of electricity and eletrification of the transport and heating and cooling sectors, presents a cost optimised means of reducing emissions.	Taken into consideration - electrification now is discussed in detail in 7.11 (formerly 7.129. Space constraints however do not allow for a detailed discussion in the ES.
2968	7	7	21			In the introduction the system boundary of the energy system should be drawn. I suggest to focus on the power sector.	Accepted - a diagram now shows the system boundaries.
6414	7	7	22	7	32	I know that this is talking about big global issues, but this may be a place to introduce how the rapid expansion of hydraulic fracturing in the United States has also lead to large revisions or changes in the energy system.	Taken into account - comment is obsolete as the underlying text has been deleted.
6165	7	7	22			No parenthetical remarks in subject headings.	Accepted - text revised.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18182	7	7	23		32	Add to paragraph: After relatively stable development in 2000-2005 (the period covered by the WG3 IPCC AR4) the global economic and energy systems entered times of high turbulence and uncertainty. Deep global economic recession of 2008-2009; extremely volatile energy prices; Arab Spring of 2011 with concerns on stability of oil supply from the Middle East and North Africa; devastating earthquake and tsunami in Japan, which remembered that a stable made the nuclear power future more uncertain; slow and uneven pace of global economy recovery impacted by the debt crisis in Europe and the USA, and finally breaking the tradition on consensus proposals for failure to reach binding agreement of GHG emission control in Copenhagen, and at following UNFCCC COPs meetings - all those events significantly altered both recent trends in energy systems developments and energy related GHG emissions, as well as assumptions for the projections and visions of the near and longterm future.	Taken into account - comment is obsolete as the underlying text has been deleted.
18183	7	7	23		32	Alternative paragraph: After a relatively stable development in 2000-2005 (the period covered by the WG3 IPCC AR4) the global economic and energy systems entered times of high turbulence and uncertainty. Deep global economic recession of 2008-2009; extremely volatile energy prices; Arab Spring of 2011 with concerns on stability of oil supply from the Middle East and North Africa; devastating earthquake and tsunami in Japan, which remembered that a stable nuclear power future more uncertain; slow and uneven pace of global economy recovery impacted by the debt crisis in Europe and the USA, and finally breaking the tradition on consensus proposals for GHG emission control in Copenhagen, and at following UNFCCC COPs meetings all those events significantly altered both recent trends in energy systems developments and energy related GHG emissions, as well as assumptions for the projections and visions of the near and longterm future.	Taken into account - comment is obsolete as the underlying text has been deleted.
10276	7	7	24	7	32	The description of "finally failure to reach binding agreement of GHG emission control in Copenhagen" should be revised. The word "failure" should not be used.	Taken into account - comment is obsolete as the underlying text has been deleted.
7726	7	7	28	7	29	Hasn't the certainty of the continuity of the Kyoto Protocol and the establishment of the commence of the second commitment period been taken into account?	Taken into account - comment is obsolete as the underlying text has been deleted.
12030	7	7	30	7	31	Not clear what this sentence wants to say. What are actually altered significantly? Please present evidences.	Taken into account - comment is obsolete as the underlying text has been deleted.
17202	7	7	33			The authors cite CO2 emissions from IEA and Enerdata. This is an important issue in the international context because IEA and Enerdata do not collect these numbers from all countries, but derive them from the energy statistics by applying IPCC methods. The problem is simply that national CO2 statics lack in several countries. China is preparing national CO2 emission statistics, but has not yet published the figures by a governmental agency. International climate policies with binding targets at the national level require national statistics. The LCAs are recommended to discuss this issue and consider a special paragraph or a box on the topic. The same is obviously the case for non-CO2 GHG emissions.	Noted - the suggestion made by the reviewer is unclear. What are the suggestions? Not to use numbers? We use data available from different sources (see section 7.2). We do agree that data quality need improvement. Additional comments on these issues are made in chapter 5.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18184	7	7	33		45	Add to paragraph: The global energy related CO2 emissions growth accelerated from 1,1% per year in 1990-2000 to 2,6% in 2001-2010, and 3% in 2011 (IEA, 2011a; Enerdata, 2012). This acceleration was mostly driven by emissions from non-Annex I countries, which in 2008 for the first time surpassed those of the Annex I countries, who managed to keep emissions since 2008 below 1990 levels (IEA, 2011a). The gap in per capita energy related CO2 emissions between Annex I and non-Annex I countries is still large, but shrunk from 6:1 to 3.7:1 in 2000-2009. Annex I countries are not any more at the top of CO2 emitting countries list. In 2007 China took the leading position in this list and in 2010 it emitted already 40% more than the second largest emitter – the USA. In 2009 it took over the USA the position of leading energy consuming nation, and in 2011 – position of the largest global electricity consumer (Enerdata, 2012). In 2010 India overcame the Russian Federation to become the third largest CO2 emitter position (IEA, 2011a). With such acceleration the global community is approaching the estimated noretturn point for 450 ppmv like scenarios leaving little additional room for maneuver and scaling up the need to introduce zeroand low-carbon technologies (IEA, 2011a).	Taken into account - comment is obsolete as the underlying text has been deleted.
18185	7	7	33		45	Alternative paragraph: The global energy related CO2 emissions growth accelerated from 1,1% per year in 1990-2000 to 2,6% in 2001-2010, and 3% in 2011 (IEA, 2011a; Enerdata, 2012). This acceleration was mostly driven by emissions from non-Annex I countries, which in 2008 for the first time surpassed those of the Annex I countries, who managed to keep emissions since 2008 below 1990 levels (IEA, 2011a). The gap in per capita energy related CO2 emissions between Annex I and non-Annex I countries is still large, but shrunk from 6:1 to 3.7:1 in 2000-2009. Annex I countries are not any more at the top of CO2 emitting countries list. In 2007 China took the leading position in this list and in 2010 it emitted already 40% more than the second largest emitter – the USA. In 2009 it took over the USA the position of leading energy consuming nation, and in 2011 – position of the largest global electricity consumer (Enerdata, 2012). In 2010 India overcame the Russian Federation to become the third largest CO2 emitter position (IEA, 2011a). With such acceleration the global community is approaching the estimated noretturn point for 450 ppmv like scenarios leaving little additional room for maneuver and scaling up the need to introduce zeroand low-carbon technologies (IEA, 2011a).	Taken into account - comment is obsolete as the underlying text has been deleted.
4805	7	7	33	7	35	What are the Annex I countries?	Taken into account - comment is obsolete as the underlying text has been deleted.
15286	7	7	33	7	34	"1,1%" and "2,6%" to be "1.1%" and "2.6%"	Accepted. Commas were replaced.
4099	7	7	36	7	42	This section is a nonsense, due to its complete overlooking of 'embedded emissions'. The transfer of manufacturing capacity from a number of industrialised nations since 1990, and their import of manufactured goods from countries such as China and India, have completely falsified emissions accounting on any intellectually honest basis. The USA, Germany, France, and the UK are clear examples. Thus instead of the UK claiming to have reduced its carbon emissions by over 20% since 1990, it has in fact increased them by over 20% once 'embedded emissions' are taken into account.	Taken into account - comment is obsolete as the underlying text has been deleted.
2821	7	7	36	7	38	This comment should perhaps point out (as on p 16) that the average is driven by the low emissions of Idcs. There is already a significant degree of overlap between Annex 1 and non-Annex 1 countries. For instance, in 2009 (IEA 2011c) per capita emissions in China, at 5.14t, were not that different from OECD Europe (6.85t). It is likely that China's per capita emissions today are above, not just those of France (as noted on p 21 – it could have added Sweden and others) but above the OECD Europe average.	Taken into account - comment is obsolete as the underlying text has been deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9780	7	7	39	7	40	suggest to delete "In 2007 China took the leading position in this list and in 2010 it emitted 40 already 40% more than the second largest emitter – the USA.", because there is no china emission data from 2007 to 2010 of GHG Data - UNFCCC, the china emission from IEA data is not The inventory data .	Taken into account - comment is obsolete as the underlying text has been deleted.
17357	7	7	40	7	41	it took over the position of leading energy from the USA, and in 2011 the position...	Taken into account - comment is obsolete as the underlying text has been deleted.
9627	7	7	41	7	44	would be useful to express this on a per capita basis as well	Taken into account - comment is obsolete as the underlying text has been deleted.
13286	7	7	42	7	43	The word 'overcame' should be replaced with 'overtook'; the word 'position' is unnecessary in this context and should be deleted	Taken into account - comment is obsolete as the underlying text has been deleted.
16775	7	7	44		45	re point "leaving little additional room to maneuver and scaling up ..." This may need further elaboration -- there is plant of room to implement and deploy a great amount o flow emitting energy technology, however there is little time left if we hope to hit a 450 ppm concentration target -- we could yet plausibly hit a 500, 550 or even 600 ppm target, but we would incur a lot more risk in doing so	Taken into account - comment is obsolete as the underlying text has been deleted.
18038	7	7	45	7	45	Define "zero- and low carbon technologies"	Taken into account - comment is obsolete as the underlying text has been deleted.
6445	7	7	45	7	45	Spelling error? manoeuver (not 'maneuver')	Taken into account - comment is obsolete as the underlying text has been deleted.
18186	7	7	46		48	Add to paragraph: Chapter 7 is dealing with energy systems, which dominated global GHG emissions and includes activities on energy sourcing, conversion, storage, transmission and distribution to supply energy to downstream energy consumers. Technical complexity of energy systems is scaling up and involves more and more conversion and delivery stages, with increasing automation and "smart" control. They are designed to produce primary energy, to convert it into secondary energy carriers, store them and deliver to final users to provide energy services in forms allowing improving both the quality of life and overall economic productivity.	Taken into account - comment is obsolete as the underlying text has been deleted.
18187	7	7	46		48	Alternative paragraph: Chapter 7 is dealing with energy systems, which dominated global GHG emissions and includes activities on energy sourcing, conversion, storage, transmission and distribution to supply energy to downstream energy consumers. Technical complexity of energy systems is scaling up and involves more and more conversion and delivery stages, with increasing automation and "smart" control. They are designed to produce primary energy, to convert it into secondary energy carriers, store them and deliver to final users to provide energy services in forms allowing improving both the quality of life and overall economic productivity.	Taken into account - comment is obsolete as the underlying text has been deleted.
6166	7	7	46	7	46	"Chapter 7 is dealing with energy systems". "Is dealing with" is poorly worded; "addressing" or "concerns" is better.	Accepted - text revised.
6167	7	7	46	8	3	The purpose of this paragraph is unclear. The first sentence seems like an introduction, and the final two are both vague and obvious. Cut.	Accepted - text revised.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2939	7	7	46	8	3	The inadequate discussion of this para (and of the first para of the chapter summary) suggests that "energy systems" in line 46 to the authors means "energy SUPPLY systems", whereas the full energy SYSTEM to me is more like "well to wheels", i.e it includes how energy is used as well as how it is supplied. And in the phrase "energy [supply] systems includes [list of examples]" is this list meant to be comprehensive? Are there other aspects also included? In short this section fails to clearly define the "boundaries of this chapter", and consequently of its relation to the other chapters on transport, buildings, industry, etc.	The scope of the chapter corresponds to definition of energy industries in the IPCC inventory Guidelines. It was made clearer. The boundaries of the system considered in chapter 7 now is explained by using a diagram.
10493	7	7	47			Throughout the chapter there is confusion over the definition of "energy sector" and what it includes. For example page 15 line 14 says energy sector is only electricity and heat - yet earlier in 7.1.1 it implies it includes some transport - up to distribution. The whole chapter needs to be checked for consistency in terminology. Suggest a small side-meeting at LAM3	Accepted - a diagram now shows the system boundaries.
16776	7	7	48			Suggest delete sentence beginning with "Technical complexity of energy systems ..." and replace with "The transformation of the energy system also provides the lowest costs opportunities for reducing CO2 emissions (chapter 6).	Taken into account - comment is obsolete as the underlying text has been deleted.
4778	7	7	9	7	20	Power system is a very long term business, which requires important amount of money. It is therefore important to have a long term vision, that is shared between all stakeholders, in order to provide confidence to investors and for them to choose the best solution (climate/energy issue).	Noted.
15938	7	7	9	7	9	please explain 'path dependent' or use another phrase	Accepted - text revised
9221	7	7	22	7	32	You can to eliminate the detail, from end line 24, because always can be forget some item. The paragraph will be: " Deep globaleconomic recession of 2008-2009 and slow recovery by the debt crisis in Europe and the USA, volatility of energy price, geopolitical tension, devastating earthquake and sunnami, and failure to reach binding agreement of GHG emission control all those events significantly...."	Taken into account - comment is obsolete as the underlying text has been deleted.
13452	7	7	13	7	14	Text: "Existing energy-related capital stock has already locked in 80% of the 14 permissible 2035 CO2 emissions under a 450ppm CO2eq stabilization scenarios" Whilst it is true that current energy-related infrastructure could lock in high future emissions, it is also true that if decarbonisation in the energy sector begins to be treated seriously, not all the current plant will remain in use, or in constant use. One scenario could be that renewable electricity generation becomes of vital importance within major economies, perhaps because of strong volatility in fossil fuel prices and availability, leading to fossil fuel plant being used only as back up for load balancing.	Taken into account - comment is obsolete as the underlying text has been deleted.
13453	7	7	38	7	39	Text: "Annex I countries are not any more at the top of CO2 emitting countries list." Alternative wording suggests itself to avoid confusion, such as "Annex I countries are in the top CO2 emitting countries list, but a non-Annex I country now holds the very top position."	Taken into account - comment is obsolete as the underlying text has been deleted.
7017	7	7 of 135	15	7 of 135	15	Add "zero and", after the word "of", and before the word "low", around the middle part of the line.	Rejected - low carbon technologies comprise zero carbon technologies as a subset.
7018	7	7 of 135	19	7 of 135	20	The same as 12th Comment.	Taken into account - Copenhagen Accord is replaced by Cancun Agreement.
11775	7	70				This figure shows wind power cost is extremely low, which means that it includes the some kind of policy support. Such remark should be added to avoid misunderstanding.	Taken into account - The comment is obsolete as the underlying figure has been deleted.
9612	7	70				Please, add in line 'a)' some condition such as if demand curve is perfectly inelastic or if supply is perfectly elastic.	Taken into account - The comment is obsolete as the underlying figure has been deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10664	7	70				This figure assumes that wind energy enjoys prioritized dispatching because of the EU directive and does not reflect its real economy. Delete or provide a proper explanation.	Taken into account - The comment is obsolete as the underlying figure has been deleted.
10570	7	70				Expand caption as insufficient to interpret the figures	Taken into account - The comment is obsolete as the underlying figure has been deleted.
11546	7	70				This page is a mix of journal article-type text and quotations from the IEA. Please harmonize style, and make sure you understand what you want to say and why. Fig 7.19 is not well-explained and could be dropped as it is not essential. Better: drop figure, move caption to main text and provide appropriate references. This is what an assessment should do.	Taken into account - text revised. Figure 7.19 is deleted.
10569	7	70	1	70	8	Needs updating with references added	Taken into account.
2849	7	70	14	70	18	This is unbalanced. The studies cited do not justify the conclusion that GHG prices were effective in changing investment decisions. A more neutral summary of Ellerman et al 2010 said that it concludes that "the EU ETS did deliver operational changes, resulting in CO2 emission reductions of 3–5% during the pilot phase relative to a counter-factual without the ETS. The authors argue that it is too early to assess the additional impact on investment choices." (Karsten Neuhoff: Reflections on implementing EU ETS, Climate Policy, 11:1). In any event the Ellerman studies relate to the pilot phase of the ETS (2005-2007) and events since then would cast doubt on whether the current scheme has even the minor impacts suggested for the pilot.	Taken into account - The text now distinguishes between operational choices and the impact on investments.
18223	7	70	19		23	Delete: A higher market clearing price implies that consumers have to pay more for electricity. "This can result in consumer payments for electricity increasing by substantially more than the actual cost of emissions allowances (Cowart, 2010)" (IEA, 2011j, p. 44). In markets that exhibit some price elasticity (e.g., due to demand response measures (IEA, 2003b)) this might result in a lower demand and consequently in lower emissions as well. Comment: As true as stated, can be seen that a lower energy demand is a desirable scenario, but this little mentioned in the chapter, and on the other hand, has much resonance with regard to improving the efficiency of energy supply technologies, or low carbon emissions, to meet a growing demand that is projected. Alternative paragraph: A higher market clearing price implies that consumers have to pay more for electricity. "This can result in consumer payments for electricity increasing by substantially more than the actual cost of emissions allowances (Cowart, 2010)" (IEA, 2011j, p. 44).	Taken into account -text revised.
12331	7	70	2			California ETS should be mentioned.	Accepted - text revised.
15546	7	70	21		23	The text seems to suggest that the only source of price elasticity is explicit demand-side policy measures. But consumers do respond to price changes if the changes are perceived to be permanent. Changing consumers' spending patterns by bringing about changes in relative prices should be a key part of climate change mitigation.	Taken into account. The reference to demand side policies has been deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18225	7	70	21		25	<p>Comment:</p> <p>In markets that exhibit some price elasticity (e.g., due to demand response measures (IEA, 2003b)) this might result in a lower demand and consequently in lower emissions as well. In contrast, a higher market clearing price implies higher infra-marginal rents for the electricity producers at least as long as the price effect is not overcompensated by additional EP expenditures (Keppler and Cruciani, 2010). The related transfer of money from consumers to producers is exaggerated, if certificates are allocated for free. Comment: As true as stated, can be seen that a lower energy demand is a desirable scenario, but this little mentioned in the chapter, and on the other hand, has much resonance with regard to improving the efficiency of energy supply technologies, or low carbon emissions, to meet a growing demand that is projected.</p> <p>Alternative paragraph:</p> <p>In markets that exhibit some price elasticity (e.g., due to demand response measures (IEA, 2003b)) this might result in a lower demand and consequently in lower emissions as well. In contrast, a higher market clearing price implies higher infra-marginal rents for the electricity producers at least as long as the price effect is not overcompensated by additional EP expenditures (Keppler and Cruciani, 2010). The related transfer of money from consumers to producers is exaggerated, if certificates are allocated for free.</p>	Taken into account - There seems to be no difference of the proposed alternative.
5961	7	70	21	23		Reducing demand for electricity (because of higher prices) does not impact overall carbon emissions (which are set by the cap). The principal effect is to reduce the price of permits.	Taken into account - the text that is referring to the emissions has been deleted.
16866	7	70	27		32	<p>There are oversimplifications here -- a free allocation above the operator's lost value in a CO2 market can create windfalls -- so if a generating station has lost \$5 of margin with at \$10 CO2 price an allocation of 1/2 allowance based on historic emissions will help cover their losses, but will not result in a windfall. A 100% allocation to the emitter (as occurred in the EU) will result in some windfall though. Also, in regard to the free allocation removing the incentive to move to low carbon generation is inaccurate -- operators respond to opportunity cost too -- it may take some time for all of them to figure this out, but they do in fairly short order - those who don't eventually go out of business because they don't understand their own economics. In fact, operators, if allowed to, can sell their future allocations on the market and use the resulting funds to finance part of the investment in the new, low emitting technology. Insofar as allocations may very well be needed to make a cap and trade program politically acceptable, it is not helpful to mischaracterize some of these points and make it more difficult to enact policies. Please see some of the literature produced by Stavins on this topic.</p> <p><a href="http://www.hks.harvard.edu/fs/rstavins/Papers/Stavins'_Article_on_US_Cap-and-Trade_for_Oxford_Review.pdf">http://www.hks.harvard.edu/fs/rstavins/Papers/Stavins'_Article_on_US_Cap-and-Trade_for_Oxford_Review.pdf</a> and <a href="http://www.hks.harvard.edu/fs/rstavins/Papers/Policy%20Instruments%20for%20Climate%20Change.pdf">http://www.hks.harvard.edu/fs/rstavins/Papers/Policy%20Instruments%20for%20Climate%20Change.pdf</a> and <a href="http://www.hks.harvard.edu/fs/rstavins/Selected_Articles/Three-Part_Architecture_Paper_for_Yale_by_Stavins_Revsied.pdf">http://www.hks.harvard.edu/fs/rstavins/Selected_Articles/Three-Part_Architecture_Paper_for_Yale_by_Stavins_Revsied.pdf</a> and <a href="http://globalchange.mit.edu/files/document/MITJPSPGC_Rpt170.pdf">http://globalchange.mit.edu/files/document/MITJPSPGC_Rpt170.pdf</a></p>	Taken into account - The comment is obsolete as the underlying text has been deleted.
9611	7	70	28	70	29	Please, explain more politely as it is unclear why in regulated systems it can also remove the incentive to move to low-carbon generation and it may be wrong. (IEA, economics of transition of the power sector)	Taken into account - The comment is obsolete as the underlying text has been deleted.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10005	7	70	34			This figure should explain that renewable energy does not always reduce the electricity price. The situation depends strongly on countries or areas. A higher 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 No26 line of this table.	Taken into account - The comment is obsolete as the underlying figure has been deleted.
5932	7	70	9		32	At the Nordic electricity market, so-called windfall profits for generators caused by ETS are very substantial, 2 billion (10^9)€/yr at the Nordic market at the CO2 price of 10 €/tonne. 50% of electricity at the market is hydropower and 20% is nuclear (both have low variable costs), and most of the time the marginal generation is coal-condensing. Removing free allocation would not remove this large transfer of money from consumers to the owners of hydro and nuclear. All of this hydro and nuclear has been built far before the EU ETS. Reference: M. Kara, S. Syri, A. Lehtilä, S. Helynen, V. Kekkonen, M. Ruska, J. Forsström, En Econ 30 (2008) 193 – 211.	Taken into account - a paragraph on the profits made by energy suppliers who run a portfolio of power plants is added. Space constraints, however, do not allow to go into the details.
12550	7	71	14			While some observers may still believe the Clean Development Mechanism is “fairly credible,” the UN's own special panel concludes that the CDM is “imperilled” for numerous reasons, and makes dozens of recommendations to rebuild programme integrity. Climate Change, Carbon Markets and the CDM: A Call to Action, Report of the High-Level Panel on the CDM Policy Dialogue, <a href="http://www.cdmpolicydialogue.org/report/rpt110912.pdf">http://www.cdmpolicydialogue.org/report/rpt110912.pdf</a>	Taken into account - The comment is obsolete as the underlying text has been deleted.
5963	7	71	17			The discussion of CDM projects and distributions has limited relevance in this section	Taken into account - text revised. The energy related aspects are now emphasized.
16867	7	71	2			Suggest inserting something like this after sentence ending with "new investments." This might be helpful: "However, investors must have confidence the market will be durable and will provide a growing CO2 price for the incentive to change investor technology choices."	Taken into account - the importance of long-term targets now is emphasized (see 7.12).
18224	7	71	21		25	Comment: Comment: The problem / scandal arising from the situations referred to the abatement of HFC-23 is very shallow in this part of the text, and the scientific community must be clearly and accurately warned about the perverse incentive that was identified in the Facility Clean Development Mechanism (CDM), in part, as to the abatement of gases with high global warming potential (as HFC-23) and their very low cost of destruction, compared to the high profits that meant selling certificates (Gillenwater and Seres, reduced emissions (CERs) that were awarded to those CDM projects. Alternative paragraph: One reason is that "early in the CDM program, a significant fraction of the emission reduction have come from a few large projects that reduced GHG emissions at low cost, for example industrial HGC and N2O abatement projects, but which delivered limited sustainable development benefits other than reduced GHGs" and low carbon energy supply (Gillenwater and Seres, 2011, p.25 30).	Taken into account - the discussion of HFC gases has been deleted, because it is not part of the energy system. The industry chapter has to take care of the HFC issue.
18226	7	71	35		37	Comment: Comment: The approach is incomplete. Should be included in the text, at least, a simple mention of what those reasons why "developing countries have not reached their potential to capture the benefits of the CDM", and not just leave it to a reference. Alternative paragraph: The reasons that explain why some developing countries don't reach their full potential to capture the benefits from CDM are discussed in (Lokey, 2009).	Rejected - space constraints do not allow a deeper discussion of these reasons.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
15367	7	71	36			Most of the LDCs and SIDs have not benefitted from the CDM at all until now. It could be mentioned that new simpler rules regarding 'additionality' of micro size (<5MW) projects and the Programmatic CDM might help smaller countries make use of this facility in near future.	Rejected- space restrictions do not allow for this extensions. The issue must be addressed in chapter 13 - 15.
15359	7	71	36	71	37	Reference missing ( Lokey, 2009)	Taken into account - reference is added.
12332	7	71	9			Emission trading systems are not necessarily limited to Annex 1 countries. By 2015, China might have both an ETS system and a CDM mechanism.	Taken into account - The comment is obsolete as the underlying text has been deleted.
9613	7	71	9	72	8	Please, move here to somewhere in chapter 13 to 15.	Rejected (in part) - Those parts that are not directly related with energy aspects have been deleted. The other parts stay in accordance to the text that is presented in chapter 13 - 15.
5962	7	71	9			As noted in previous text, ETS systems are also under development in non-Annex 1 countries.	Taken into account - The comment is obsolete as the underlying text has been deleted.
13696	7	71	9	72	8	Focus text on energy-related aspect of CDM and delete figures (general aspects of CDM as well as of its contribution to technology transfer are covered in Ch. 13 and 14). Use energy-specific CDM references such as Michaelowa, A., Hayashi, D., Marr, M. (2009): Challenges for energy efficiency improvement under the CDM—the case of energy-efficient lighting, in: Energy Efficiency, 2, p. 353-367; Lokey, E. (2009): Renewable energy project development under the Clean Development Mechanism: A guide for Latin America, Earthscan, London; Michaelowa, A.; Krey, M.; Butzengeiger, S. (2006): Clean Development Mechanism and Joint Implementation: New Instruments for Financing Renewable Energy Technologies, in: Assmann, D.; Laumanns, U.; Uh, D. (eds.): Renewable energy, Earthscan, London, p. 196-216. The CDM is a significant incentive for expansion of renewable energy (see e.g. Purohit and Michaelowa (2007) and Restuti and Michaelowa (2007) for the potential of bagasse cogeneration under the CDM in India and Indonesia.)" References: Purohit, P.; Michaelowa, A. (2007): CDM potential of bagasse cogeneration in India, in: Energy Policy, 35, p. 4779-4798; Restuti, D.; Michaelowa, A. (2007): The economic potential of bagasse cogeneration as CDM projects in Indonesia, in: Energy Policy, 35, p. 3952-3966. Update CDM data when finalizing AR5 as per the latest edition of UNEP Riso Centre: CDM pipeline, download at www.cdmpipeline.org. In case of interest, I'd be happy to draft a para of the role of the CDM in the energy sector as a contributing author.	Taken into account - text revised.
15067	7	71	10	71	13	This sentence is simply a re-written of what Art. 12 of the Kyoto Protocol stated without any additional elements. Therefore, the references (Boyd et al., 2009; van der Gaast et al., 2009) in the present text are not needed here.	Taken into account - text has been deleted.
3459	7	71	17	71	37	I suggest to include some figure and comments regarding the contribution of CER in GHG reduction	Taken into account - the energy related aspects are now emphasized.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
15068	7	71	23	71	25	The text says "but which delivered limited sustainable development benefits other than reduced GHGs". However, this seems to be an individual view which is expressed by a single paper (Gillenwater and Seres, 2011) without any formal discussions about what sustainable development benefits are. Under the current CDM process, each developing country hosting the CDM project can determine what is meant by "sustainable development". In this context, it is not so easy to conclude that HFC and N2O projects deliver limited SD benefits since such value judgment has to be done by the developing countries hosting these projects. Gillenwater and Seres (2011) does not provide any evidence to prove this.	Taken into account - the CDM text has been rewritten. Gillenwater and Seres are not cited anymore.
15369	7	72	1			UNFCCC CDM Technology Transfer report (2010): <a href="http://ynccf.net/pdf/CDM/CDM_and_Technology_Transfer.pdf">http://ynccf.net/pdf/CDM/CDM_and_Technology_Transfer.pdf</a>	Taken into account - the general aspects of technology transfer are discussed in chapter 13 - 15.
10571	7	72	16			Add ref REN21, 2012 after "recent years"	Editorial - added.

**Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7**

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9479	7	72	18	72	20	<p>It should be added that FIT system can impact civil life and economic activities by rise in the price of electricity and policies of FIT need to be decided in full consideration of such impacts.</p> <p>In a study on FIT in Germany, Manuel Frondel et al. [1] point out the following points; a)Currently, the feed-in tariff for PV is more than eight times higher than the electricity price at the power exchange... Given the net cost of 41.82Cents/kWh for modules installed in 2008, and assuming that PV displaces conventional electricity generated from a mixture of gas and hard coal with an emissions factor of 0.584 kg carbon dioxide (CO2) per kWh, then dividing the two figures yields abatement costs that are as high as 71€ per tonne. ....abatement cost estimates are dramatically larger than the current prices of CO2 emission certificates. b) numerous empirical studies have consistently shown the net employment balance to be zero or even negative in the long run, a consequence of the high opportunity cost of supporting renewable energy technologies. c) rather than promoting energy security, the need for backup power from fossil fuels means that renewables increase Germany's dependence on gas imports, most of which come from Russia. d)... the system of feed-in tariffs stifles competition among renewable energy producers and creates perverse incentives to lock into existing technologies</p> <p>[1]Manuel Frondel, Christoph M. Schmidt, Nolan Ritter and Colin Vance (2010) Economic Impacts from the Promotion of Renewable Energy Technologies: The German Experience. Ruhr Economic Paper #156 (Energy Policy 38 : 4048-4056)</p> <p>a) page 6 lines 4-6, page 13 lines 20-25 b) – d) page 19 lines 31- page 20 line 3</p>	<p>Rejected - a) the support for innovative technologies like PV is carried out via additional support schemes, because their abatements costs are higher than those observed in the carbon markets. If this would not be the case, any additional support would be not necessary. Complementary policies in addition to carbon pricing can be justified if other goals beyond climate protection (abatement of local air pollution, increased energy access, etc.) are pursued and/or technological learning is to be enhanced. Details on the issues that arise if policy instruments are applied simultaneously are discussed in detail in the policy chapter of the IPCC SRRREN. b) Space constraints do not allow the discussion of co-benefits of policy instruments. These are discussed in the subchapter on 7.9.1. c) Renewable energies displace fossil fuels. Taken together, their absolute usage is reduced. As a back-up technology, gas might be preferred, but the full load hours of gas-burning plants are declining as well. d) Feed-in tariffs are often used to support the technological learning of those technologies which are not yet competitive with others. Avoiding a competition therefore is not necessarily a weakness of the FIT, it can be its strength.</p>

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9512	7	72	18	72	25	add the bad influence for TIF in addition to the good influence (Economic impacts from the promotion of renewable energies: The German experience/page 6 lines 3-6)(attached on email)	Rejected - the cited sentences summarize the outcome of a comprehensive assessment that has been made for the IPCC SRREN. Space constraints do not allow to go into the details here. The paragraph therefore is silent about specific implications of the promotion of renewable energies. In addition, the German situation is not representative for the average of the support schemes applied on Earth.
9614	7	72	22	72	30	Please, move here to line 32 in page 70.	Taken into account - comment is obsolete. Underlying text has been deleted.
5965	7	72	24	30		Relocate to Page 69 after line 24 for better balance	Taken into account - comment is obsolete. Underlying text has been deleted.
16133	7	72	25	72	29	The paragraph rightly describe that merit order effects may lead to future unbalance in electric systems with increasing share of RE, and will induce other mechanisms (such as capacity credits or auctions). But it fails to say that presently it shakes existing baseload plants and even more projects, and have an accelerating impact on restructuring, by undermining amortization of these baseload plants. In the most obvious case, Germany, it illustrates the fact that independant renewable sources bring competition and shakes the sector. Thus "merit order effects" are independant from the context of subsidies, but more a competition issue. The paragraph should be more balanced in that direction.	Taken into account - comment is obsolete. Underlying text has been deleted.
16869	7	72	25			Re the point about renewables lowering the wholesale energy price -- this in fact creates a problem insofar as the lower price causes growth in consumption of electricity which is counterproductive when also trying to incentivize energy efficiency investment.	Rejected - this is only true for consumers that don't have to pay for the support itself (e.g. the payments compensating the feed-in tariff). At the consumer level, electricity prices often increase if renewables are supported.
5964	7	72	27	30		Objectivity: Strong support for "energy only" markets is also expressed with a view that the necessary back-up and other services can be provided in a competitive manner	Taken into account - The comment is obsolete as the underlying text has been deleted.
4826	7	72	31	72	31	One point missing in this section is the impact of economic crisis in the implementation of enabling policies. There is usually a trade-off between affordability and green targets and the affordability aspect gains importance during economic crisis.	Rejected - this implies to general aspects of mitigation policies. It therefore must be discussed in chapter 13 - 15.
10572	7	72	31			Cross reference to chapters 12-16 where appropriate	Taken into account - text revised with references to Chapter 15 and others as required

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5966	7	72	34	35		Lack of policy instrument coherence is a critical point and needs further emphasis	Rejected - the coherence of policies must be judged from a general point of view. This is to be done by chapter 13-15 and chapter 3. A reference to the respective discussion in the SRREN has been added.
14896	7	72	42	73	8	overlap to chapter 15	Taken into account - overlap has been resolved.
17379	7	72	44			network constraints...	Editorial
11997	7	72	6	72	8	I question the scientific rigour of that study because of the very evidence that over 50% of the CERs issued to date come from industrial gas projects, the technology of which has been developed in Canada, Norway and Germany. Also, the studies base their conclusions of the technology transfer description in the CDM Project Design Documentation, which is also wrong because that description is voluntary and non-scientific i.e. non-comparable. And finally, technology transfer needs to be looked at in time: As an example, the installed wind capacity in China was less than 100MW before the CDM was used to top up Chinese tax money to heavily subsidize renewable energy from 2002 onwards. The first CDM projects all used predominantly Danish, Spanish and German technology. Today, in less than a decade, there is no more technology transfer in that very sense, because the country has caught up with the development. Besides the hardship that might pose in terms of intellectual property rights etc., the bottom line is: there has been massive amount of technology transfer under the CDM and it is beneficial to mitigate GHG emissions. Also, I suggest to look at the UNFCCC Secretariat's assessment of technology transfer, you can find their study here: <a href="http://cdm.unfccc.int/about/dev_ben/index.html">cdm.unfccc.int/about/dev_ben/index.html</a>	Taken into account - the reference Das (2011) has been deleted.
2850	7	72	9	72		This section needs to be expanded, in particular the reference to wholesale market design. Market reforms are currently under way in many countries and deserve discussion. (See for example, Newbery Reforming Competitive Electricity Markets to Meet Environmental Targets in Economic of Energy and Environmental Policy vol 1 issue 1.)	Rejected - elements of a new market design are already discussed in 7.12.3 (previously 7.11.4) enabling policies. Space constraints do not allow an extension of the discussion.
16868	7	72				This section is important -- should include discussion regarding how policies focused on deploying renewables (rather than reducing CO2 emissions) may be very effective at deploying renewables, but are less effective at reducing CO2 emissions. Emissions reductions they do cause cost much more in terms of the money invested than other lower costs options that would otherwise be pursued as part of the market based program. This will drive down the CO2 price in a parallel cap and trade system, but this means that reductions that would otherwise have occurred as a slightly higher CO2 price are overlooked/not done. Forcing deployment of nascent technologies still being developed can be part of an RD&D program (and dramatically lowers costs of future techs) but if they only push techs that are already fairly mature, this is an expensive diversion of resources. Suggest looking at lit by Ellerman and others.	Rejected - space constraints do not allow for an elaborated discussion of the co-benefits and drawbacks of combining various instruments. The question of coherence is discussed in detail in the policy chapter of the IPCC SRREN. Additional information on that issue should be provided by the policy chapters 13 - 15 and chapter 3. A sentence pointing to the problem is added together with references to the aforementioned sources.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
13222	7	72	10	72	14	It might be helpful to start with the more general point that no significant deployment of grid connected renewables has been observed to date in the absence of support mechanisms. This puts then the question on efficiency/effectiveness of support mechanisms into perspective.	Taken into account - The text has been revised to be clear on which support mechanisms packages have been successful in boosting renewable penetration.
11002	7	72	18	72	22	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 introducing renewable energies rapidly.	Rejected - space constraints do not allow to go into the details here. The sentences cited summarize the outcome of a comprehensive assessment that has been made for the IPCC SRREN. Specific merits and drawbacks of different policies supporting renewable energies are discussed in the policy chapter of the IPCC SRREN.
13221	7	72	22	72	30	The renewable support mechanisms are not responsible for the merit order effect. Whenever a cheaper technology comes to the market it will replace more expensive generation assets (in hours or in overall system). Thus the merit order effect is neither an argument against support mechanisms nor against the viability of an energy market including large shares of renewables.	Taken into account - comment is obsolete. Underlying text has been deleted.
13208	7	72	9			Nuclear energy contribution to GHG emissions reduction should be discussed, e.g. for China	Rejected. Section 7.11.2 describes technology policies to complement carbon pricing. "Nuclear energy contribution to GHG emissions reduction" is described in nuclear technology section.
10956	7	72	9	72	30	Confer: Fischer, Torvanger, Shrivastava, Sterner, Stigson (2012), How should support for climate-friendly technologies be designed?, <i>Ambio</i> , 41(Suppl. 1), 33-45.	Noted. The suggested literature picks up several important policies. However, any discussion of the design of policies now is left to chapter 13 -15 due to space constraints.
10092	7	72		73		If enabling policies are described, the opposite should also be mentioned, which are plenty.	Rejected - barriers are discussed in chapter 7.10
18104	7	73	3	73	3	... nodal pricing schemes, ancillary services markets and capacity markets.	Accepted - text revised.
9615	7	73	37	74	75	Please, delete here due to duplication in chapter 6.	Rejected. The figure and text is essential to provide the context for the required energy system changes that follow.
7746	7	73	40	74	2	There is no reason to refer to na accord, which is not unanimously adopted by the UNFCCC. Please, refer to the Kyoto Protocol.	Taken into account - the Copenhagen Accord has been replaced by the Cancun Agreement.
6461	7	73	40	74	2	Copenhagen Accord does not set the objective of limitation of global average temperature change to below 2 degrees, but just "recognizing the scientific view". Therefore, the sentence should be changed to, for example; "which is broadly compatible with scientific view recongnized in the Copenhagen Accord to limit global average temperature increase to below 2°C".	Taken into account - the Copenhagen Accord has been replaced by the Cancun Agreement.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
12596	7	73	6			There is an ethical issue over smart grid technologies. Do we go down the route of somewhat invasive systems, which give energy providers control over the devices in domestic homes, or, alternatively, do we go down a more decentralized type system, using systems which monitor the local grid frequency?	Rejected - although the question is interesting, space constraints do not allow for a deeper discussion based on the peer-reviewed literature
3460	7	73	1	73	30	It should be mentioned that there is a lack of regulation among countries, on order to take advantages of some energy and environmental solutions that could be implemented among countries	Rejected - the discussion of general policy aspects is to be done by chapter 13-15 and chapter 3.
2851	7	73	31	86	8	As mentioned in the general section the scenarios section could be shortened. There are one or two significant findings, such as the importance of demand and electricity and the need for immediate action. However, apart from those (familiar) points, no clear or useful message emerges, given the huge range of outcomes quoted from different models, and the cursory checklist of policies.	Accepted. We made an attempt to shorten the text wherever possible
9069	7	73	31	86	8	7.12 Sectoral implication of transformation pathways and sustainable development can be deleted due to limitations on the nos of pages and it's been covered in chapter 6	Rejected. We disagree that the pages are covered in chapter 6.
3161	7	73	31			Section 7.12 covers SD, but that is addressed in detail in a whole chapter (#4, I think).	Noted - we are bound by the heading to cover it.
18549	7	74		75		Why do energy and industry appear together in this figure? The AR5 has a separate chapter for each of these sectors, and one would therefore expect this figure (and section) to therefore focus strictly on energy.	Noted. This is so since some scenarios report industrial process emissions as part of the energy related emissions. we can not exclude these emissions. Note also that energy-related emissions refer to the full energy system including emissions of all demand-side sectors. In addition, non-energy emissions from industrial processes are included, since these emissions are not provided as a separate category in the AR5 scenario database (and can thus not be broken out as a separate categories). The text clarifies however the relatively small share of the emissions in the total
14547	7	74	18	74	18	Express targets also in more familiar concept of CO2 concentration (ppm)	Accepted
9480	7	74	22	74	23	Suitable sites for renewable energy or CCS are eccentrically-located and installation of them requires great cost. should be added that there are difficulties to make world's average emission factor of electricity to zero.	Rejected. Costs are discussed elsewhere in the chapter. Whether or not they are "great" is a matter of personal interpretation.
6554	7	74	1			"2.5-3.0" instead of "2.7" is correct (see Table 6.2). The same in P.74 line18, and P.83 line5.	Taken into account - the definition of the categories has been updated.
6555	7	74	1		2	Correct the description "stated objective of the Copenhagen Accord to limit global average temperature change to below 2 degrees C.", as the heads of state, etc. have agreed on the Copenhagen Accord only "recognizing the scientific view that the increase in global temperature should be below 2 degrees Celsius" but not on "objective to limit temperature below 2 degrees C".	Taken into account - the Copenhagen Accord has been replaced by the Cancun Agreement.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6556	7	74	2		5	Make numbers consistent with those in Chapter 6.	Taken into account - results in chapter 6 and chapter 7 now are consistent.
6558	7	74	16		17	Replace "The stabilization of GHG" with e.g. "the lower stabilization levels of GHG", as there seems to be scenarios suggesting CO2 emissions to peak-out and then decline even in the baselines of Figure.21.	Accepted. The section has been changed to indicate that the increase is relative to present levels.
6559	7	74	21		22	Delete the sentence "As discussed [...] concentrations." or replace "CO2 emissions must eventually decline to zero" with e.g. "CO2 emissions must peak and then gradually approach zero over more than 1000 years" according to Kheshigi et. al (2005) cited in 7.12.4 to make it clear, as the other discussion here is only dealing with issues in this century.	Accepted. changed to read, "in the long term decline toward zero"
6557	7	74	7		8	Modify the description "energy-related CO2 emission are expected to continue to increase", as the lower boundary of baselines on Figure 7.21 suggests that there are scenarios that indicate CO2 emissions to peak-out and then decline even in the baselines.	Accepted. The section has been changed to indicate that the increase is relative to present levels.
12333	7	74	6			This chapter should also deal with emission of SF6 from electric transmission systems.	Accepted - Unfortunately the AR5 scenario database does not include sufficient detail to break out information about SF6 emissions from electrical transmission systems. But we acknowledge that this omission should be made clear. Additional information on SF6 emissions is given in chapter 7.8.1.
4656	7	75			75	I think the categories should be specified in the figure.	Taken into account - the categories now are explained in the introduction to section 7.11.
10573	7	75	2			Does "the energy and industry sector" include transport and buildings? Seems a strange combination. Why is industry included in this chapter? Another example of where chapter boundaries are hazy	Noted. This is so since some scenarios report industrial process emissions as part of the energy related emissions. we can not exclude these emissions. Note also that energy-related emissions refer to the full energy system including emissions of all demand-side sectors. In addition, non-energy emissions from industrial processes are included, since these emissions are not provided as a separate category in the AR5 scenario database (and can thus not be broken out as a separate categories). The text clarifies however the relatively small share of the emissions in the total
16870	7	75	21		24	Replacing the fossil fuel share of energy is not precise enough -- should be replacing the high emitting fossil fuel technologies with low emitting fossil fuel technologies. See chapt 6 re the importance of CCS on fossil fuels as part of low costs mitigation scenarios.	Accepted. We clarified that we mean the fossil fuel share without CCS.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16871	7	75	25		29	Very good that you mention that the scenarios show that energy efficiency is a large contributor of emissions reductions in the first decades of a CO2 reduction program that is driven by a CO2 price -- might also be helpful to note why this is so (EE is relatively inexpensive, other larger new technologies are not quite ready or require a higher CO2 price expected in future decades, etc.).	Rejected: in the IAMs every technology is deployed up to the point at which the last ton of emissions mitigation costs the same. So, nothing is any cheaper than anything else at the margin.
2852	7	75	27			The suggestion that 40-90% of reductions can be achieved via demand reduction deserves more extensive analysis – for instance, how realistic this is, how it might be achieved, and what are the implications for the various systems issues listed in the general comments above. The suggestion is far reaching in its implications, but it does not seem to be reflected anywhere in the earlier sections.	Rejected: Demand reductions are discussed extensively in the chapters on industry, buildings and transport
18550	7	75	9	77		Please clarify why these three scenarios were chosen for focus.	Accepted - Because they represent broader GHG mitigation strategies with varying emphasis on demand vs. supply-focus of the transformation. We clarified this further in the text.
11953	7	75	2			Why are we repeating what is also in Chapter 6? Simply refer to it, with p. #	Noted: This section elaborates on the energy supply and transformation implications of the scenario literature as achieved in the Chapter 6 data base. It may not be possible to discuss every scenario in the literature explicitly. If scenarios include important NEW information that lies outside of the larger literature captured in the data base we will attempt to take note.
6201	7	75		78		Here, there doesn't seem to be enough text to explain the charts. Pointing out the key features of the various models being presented would help a reader follow what's being shown by all the colored blocks.	Rejected due to space limitations. Key features of models would need to be discussed in the transformation pathways chapter
17279	7	75	4	79	8	In this section also attention should be paid to low energy pathways that are not part of an integrated assessment model, like the one developed by DLR for Greenpeace (Energy [R]evolution) and by Ecofys for WWF (The Energy Report). These scenario studies often provide more detail in terms of the deployment of renewable energy	Rejected - the IPCC scenario database is an open one. Please submit the respective scenarios so that they can be included.
10059	7	75	8	78	11	More scenarios should be added - especially those with different technology pathways (excluding e.g. CCS)	Accepted: We consider scenarios that exclude many technologies including, CCS and nuclear, and those which limit availability and performance of bioenergy and other renewables.
16872	7	76				Are you not going to discuss or mention possible overshoot scenarios? Chapt 6 discusses them. If the world is slow in arriving at an agreement (really, emissions trading) among major emitting countries, overshoot strategies are the only way we ultimately can arrive at a 450 or 500 ppm world.	Rejected - implications of overshoot scenarios are discussed in chapter 6.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4657	7	76		76		I had difficulty following this figure. In two of the baseline scenarios, the biomass numbers decline to 2050 and then only start to increase to reach a maximum of 200 EJ by 2100. There is nothing shown for CCS. But surely, new tree planting entail CCS? Also the existing yields from wood, agricultural residues and dung are of the order of 500-515 EJ. This is well in excess of the 200 EJ shown in the table. The tables on the left which include CCS underground, have a maximum figure of less than 400EJ, which is again less than the current accessible annual yield!	Noted. We are trying to make our message clearer and the figures easier to follow.
10278	7	77		77		The role of nuclear power for the 450 ppm stabilization scenario is slightly smaller than that for the baseline scenario in MESSAGE and ReMIND models in Figure 7.22. The results will come from the assumptions of the models which have the exogenous scenario or limitation of nuclear power capacity or generations considering the public acceptability. However, such assumptions lack a scientific basis and are determined by modelers on an ad-hoc basis. There is a concern that readers will misunderstand the role of nuclear power inadequately without understandings of such model assumptions. Therefore, the additional explanatory remarks of the figure discussed above should be added in the body text in order to avoid misunderstandings of readers.	Rejected. Reduced deployment of nuclear or solar or wind in mitigation scenarios as compared with the reference case occurs when the expanded share of nuclear in power generation is offset by reduced demands for electricity occurring because end-use sectors are conserving energy in general.
11776	7	77				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.	Rejected. Reduced deployment of nuclear or solar or wind in mitigation scenarios as compared with the reference case occurs when the expanded share of nuclear in power generation is offset by reduced demands for electricity occurring because end-use sectors are conserving energy in general.
9616	7	77				Please, describe reasons for reduction of nuclear capacity in the text with regard to two models results, MESSAGE and ReMIND after 2080's; it may mislead readers to conclude that nuclear generation is no longer regarded as one of critical options. However, IEA indicates nuclear is still a significant source in some cases in 2050 (IEA, table 3.1, ETP 2010) and its trend continues.	Rejected. We don't have the space to discuss individual technology contributions in specific scenarios. (Also, see previous response.)
9617	7	77				Please, describe reasons why nuclear deployment becomes low relative to other sources in the text. IEA shows two cases of normal and high nuclear deployment in table 3.1, ETP 2010, which differs from those in Figure 7.23.	Rejected. We don't have the space to discuss individual technology contributions in specific scenarios. (Also, see previous response.)
10093	7	77				axis legends are missing "savings" is misleading as nothing is on an account to be used in the future. "Efficiency increase" suits better.	Accepted: the effect includes also other demand-side changes than efficiency. Changed the legend to "efficiency/demand"
10006	7	77				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.	Rejected. This would require too much specific scenario detail. The interested reader needs to go back to the original source.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6702	7	77	2			In this figure, the role of nuclear energy for the 450 ppm stabilization scenario is smaller than the baseline scenario in MESSAGE and ReMIND models. It is thought that this result come from the assumptions of the models which have the exogenous scenario or limitation of nuclear energy capacity or generations considering the public acceptability. Such assumptions lack a scientific basis and are determined by modelers on an ad-hoc basis. The additional explanatory remarks of this figure are needed in order not to make readers misunderstand the role of nuclear energy.	Rejected. We are able to discuss the general nature of scenarios but not the role of specific energy supply and transformation technologies. The role of nuclear technology is discussed along with other mitigation technologies.
11777	7	78				Nuclear ratio is almost same. If this results come from the some kind of given conditions to the model, such remark should be added.	Rejected. We don't have the space to discuss individual technology contributions in specific scenarios. (Also, see response 11776.)
4658	7	78		78		For biomass, it appears that the 'low' figure is higher that the 'medium' figure. Why?	Taken into account - comment is obsolete. Figure has been deleted.
17756	7	79				consider dividing this important figure into four segments - at present it is fully readable	Taken into account - comment is obsolete. Figure has been deleted.
9665	7	79				this figure is completely confusing - I am not sure that it adds value	Taken into account - comment is obsolete. Figure has been deleted.
7305	7	79		79		For better reading, please, change the colour of the filling and increase the size for the Figure 7.24.	Taken into account - comment is obsolete. Figure has been deleted.
6250	7	79		81		this seems as though it should be one of the central premises of the entire chapter. But that's not the case here; it's 4 paragraphs and a couple of charts spread out over 2 pages near the end of the chapter. It is actually shorter in text than the next subsection which summarizes literature on the difficulty of long-term stabilization planning.	Noted: This is one of several important points. The fact that it is a separate subsection means that it is important.
16873	7	79				I don't find this chart very helpful or informative -- can it be simplified and parts enlarged?	Taken into account - comment is obsolete. Figure has been deleted.
16874	7	79	12			It might be helpful to note at the end of the paragraph the following: "In short, the electricity sector provides the new energy refining infrastructure for the low emitting future."	Rejected: We emphasize the role of power generation in emissions mitigation strategies, but reject the specific wording
10574	7	79	17	79	20	Suggest delete these last two sentences as they relate more to transport than to electricity sector. But if they stay, then change "Bioenergy" to "Biofuels"	Accepted: We no longer discuss the transport sector, but refer readers to the Transport chapter.
18105	7	79	21	79	23	Add efficiency and demand side measures.	Reject. That does not belong in a chapter on energy supply and transformation.
9165	7	79	4	81	5	role of electrification is discussed in (Sugiyama 2012) - please refer. (it is in ch6 bibliograph)	Noted - space constraints do not allow to go into the details here.
16875	7	79				Very good. Please make sure this is highlighted in the executive summary.	Noted.
10497	7	8				No mention of the Bioenergy section in Exec Summary. If it is to stay here needs a paragraph - but will maybe move to Chapter 11 I suspect.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
9628	7	8	1	8	1	Who or What is being referred to when you say "they"?	Energy systems.
15939	7	8	1	8	3	Energy systems are not designed to produce primary energy; they are designed to deliver energy services to end users. Whether or not they 'produce' primary energy is irrelevant, as in the case of wind, solar, there is no 'primary energy' involved, unless you count the kinetic energy in the wind or the fusion reaction in the sun as 'primary' energy - and in any case, the energy system doesn't 'produce' it.	Taken into account - comment is obsolete as the underlying text has been deleted.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
6415	7	8	13	8	13	Should "intermittency" be "variability"?	Taken into account - comment is obsolete as the underlying text has been deleted.
18042	7	8	13	8	13	"Balancing" is a better word than "intermittency" here if it relates to the broader operation of electricity systems.	Taken into account - comment is obsolete as the underlying text has been deleted.
15940	7	8	13	8	13	replace 'intermittency' with 'variability', since this is what is being referred to here, I believe. Wind and solar are not intermittent - they are variable. Intermittent is a nuclear reactor which can go from 1000 MW to zero in a fraction of a second - and systems need to deal with that as well. So, add 'variability' to intermittency, or just switch intermittency to variability - the latter is I think the simplest.	Taken into account - comment is obsolete as the underlying text has been deleted.
3774	7	8	14	8	16	Review wording.	Accepted -text revised.
5149	7	8	14		16	simpler sentence may clarify message	Accepted text revised.
17359	7	8	15			impacts or may impact...	Accepted - text revised.
18188	7	8	30		40	Add to paragraph: This chapter concentrates on mediumterm projections (to 2030-2035). Comparisons with stabilization pathways allow understanding the gap and challenge, including sustainable development implications of rapid transformations and disruptive changes. Local fuel supply infrastructure is the subject of Chapter 8. Building integrated power and heat generation as well as biomass use for cooking are addressed in chapter 9. Responsive load issues are dealt with by chapters 8 and 9. Chapter 7 considers mitigation options in fossil fuel energy extraction industries (oil, gas, coal, uranium etc.) while other extractive industries are addressed in Chapter 10. This chapter considers energy storage, and addresses the transformation of wood into charcoal, but not natural forest management This chapter addresses the transformation of wood into charcoal, but does not address natural forest management. This chapter also considers energy storage. Only energy sector related policies are reviewed considered in this chapter while broader and more detailed policy picture is presented in chapters 13-15.	Rejected - comment is unclear. Please clarify what you would like to change.
18189	7	8	30		40	Alternative paragraph: This chapter concentrates on mediumterm projections (to 2030-2035). Comparisons with stabilization pathways allow understanding the gap and challenge, including sustainable development implications of rapid transformations and disruptive changes. Local fuel supply infrastructure is the subject of Chapter 8. Building integrated power and heat generation as well as biomass use for cooking are addressed in chapter 9. Responsive load issues are dealt with by chapters 8 and 9. Chapter 7 considers mitigation options in fossil fuel extraction industries (oil, gas, coal, uranium etc.) while other extractive industries are addressed in Chapter 10. This chapter considers energy storage, and addresses the transformation of wood into charcoal, but not natural forest management This chapter also considers energy storage. Only energy sector related policies are reviewed this chapter while broader and more detailed policy picture is presented in chapters 13-15.	Rejected - comment is unclear. Please clarify what you would like to change.
10494	7	8	32			Local "transport" fuel supply....	Accepted - text revised.
10495	7	8	35			Not clear how "Responsive load issues" are dealt with in Chapter 8. Need to clarify or amend.	Noted - please read chapter 8.
10496	7	8	38			... management, "which is covered in Chapter 11."	Accepted - text revised.
9629	7	8	4	8	25	This is not necessary - one can read it in the table of contents	Rejected - a short description of the content is necessary in order to guide the reader.
18041	7	8	4	8	10	Needs reformulation	Accepted - text revised.
6168	7	8	4	8	40	Sentence structure like this is acceptable in the context of an introduction. However, the length of this paragraph and its repetition makes it ineffective. Consider splitting it up at the very least, preferably rewriting it entirely.	Accepted - text revised and shortened.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17358	7	8	4			what is new and different...	Accepted - text revised.
3773	7	8	4	8	5	Improve wording.	Accepted - text revised.
5148	7	8	4		4	unclear sentence	Noted - please clarify what is wrong?
11913	7	8	4			should be ...what "is" new...	Accepted - text revised.
16032	7	8	4	8	40	Not necessary	Rejected - a guidance for the reader is necessary. However, the text has been rewritten and shortened.
4806	7	8	41	8	50	Use past tense for the summary of AR4	Taken into account - comment is obsolete. Overview of AR4 was deleted.
18190	7	8	42		48	Add to paragraph: 4AR concluded that the world is not yet on a course to achieve a sustainable energy future. Mitigation has therefore become even more challenging. Decisions taken today that support the deployment of long lasting carbon-emitting technologies could have profound effects on GHG emissions for the next several decades. Without the near-term introduction of supportive and effective policies taken by governments, the global energy supply will continue to be dominated by predatory extractive methods for energy production, increasing environmental degradation and social inequality. By fossil fuels for several decades and total greenhouse gas (GHG) emissions arising from the global energy supply sector continue to increase. Comment: Government policies should not only refer to the support and promotion of low-carbon technologies for energy supply, but policies to reduce energy demand in itself is an urgent need, especially in terms of per capita consumption.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
18191	7	8	42		48	Alternative paragraph: 4AR concluded that the world is not yet on a course to achieve a sustainable energy future. Mitigation has therefore become even more challenging. Decisions taken today that support the deployment of long lasting carbon-emitting technologies could have profound effects on GHG emissions for the next several decades. Without effective policies by governments, the global energy supply will continue to be dominated by fossil fuels for several decades and total greenhouse gas (GHG) emissions arising from the global energy supply sector continue to increase.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
2257	7	8	42	8	42	Sustainability is impossible. There are only two directions, forward and backward. You seem to choose backward	Taken into account - comment is obsolete. Overview of AR4 was deleted.
6169	7	8	42	9	25	It is unclear how this section is a summary of AR4. Claims like "no single policy instrument will ensure the desired transition to a future secure and decarbonized world" are uncontroversial and read like meaningless platitudes. Suggest that this entire section be cut, and bring up AR4 when current conclusions are significantly different.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
3775	7	8	42	8	42	Replace "4AR" by "AR4".	Taken into account - comment is obsolete. Overview of AR4 was deleted.
15287	7	8	42	8	42	"4AR" to be "AR4"	Taken into account - comment is obsolete. Overview of AR4 was deleted.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18192	7	8	49		50	Add to paragraph: The wide range of energy sources and carriers that provide energy services need to offer energy access for all, longterm energy security, be affordable and have minimal impact on climate and the environment. To reduce the resultant GHG emissions will require a transition to zero and lowcarbon technologies. This transition has begun and there is large mitigation potential available for increased deployment at costs below 20 US\$/tCO2. Environment as a whole, on the way to hybrid energy systems. This includes reduction of GHG emissions and the deployment of low-carbon technologies, considering that there is yet large mitigation potential available at costs below 20 US\$/tCO2.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
18193	7	8	49		50	Alternative paragraph: The wide range of energy sources and carriers that provide energy services need to offer energy access for all, longterm energy security, be affordable and have minimal impact on environment as a whole, on the way to hybrid energy systems. This includes reduction of GHG emissions and the deployment of low-carbon technologies, considering that there is yet large mitigation potential available at costs below 20 US\$/tCO2.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
13287	7	8	5	8	5	The words 'pre sets' here is a typo - presumably should be replaced with 'presents a'	Accepted - text revised.
4100	7	8	50	8	50	Not just 'long-term energy security'. The problems arising from intermittency, especially of wind power, should be specifically acknowledged.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
9590	7	8	41	9	25	Please, delete here.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
11914	7	8	41			Question the need for this entire section. Should best be covered in Chapter 1 along with general summary review of everything	Taken into account - comment is obsolete. Overview of AR4 was deleted.
18499	7	8	41			Please cite the AR4 directly including references to the particular AR4 chapters, and be very careful with paraphrasing (which has the potential to be politically problematic).	Taken into account - comment is obsolete. Overview of AR4 was deleted.
18500	7	8	41			The text in this section doesn't seem to focus on the findings of the AR4 energy chapter. A reader would expect a brief summary of the main AR4 energy chapter findings, as well as the differences in this AR5 chapter, and a guidance to the AR5 sections in which a discussion of those innovations/updated results can be found.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
6546	7	8	42			Indicate which part of "4AR concluded that the world is not yet on a course to achieve a sustainable energy future."	Taken into account - comment is obsolete. Overview of AR4 was deleted.
10279	7	80		80		Good figure.	Noted
9482	7	80				Figure 7.25 should be left in this report, as it is a correct estimation that limiting CO2 emissions will increase share of electricity.	Accepted
4463	7	80		80		This figure is missing a legend for the bars.	Accepted: we added definitions of the categories in the introduction to section 7.11.
6762	7	80				Good figure. It's very important.	Noted
3805	7	80				Add explanation about C4, C3, C2, and C1.	Noted
10575	7	80				Define C1 to C5 as a caption footnote eg: "Categories C1 to C5 are defined in Fig. 7.21." Consider whether graphs relating to electricity in transport fit in this chapter. My view is that they don't and should go to Chapter 8. But if stay, then at least give a cross reference to Ch 8. Can a breakdown be made of "other non-transport" into buildings and industry. Then these can go to Chapters 9 and 10. No rference given, or in text other than "Mitigation studies show....." Which studies?	Agreed. The figures for transport should be deleted, as similar analysis was added to Chapter 8

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10007	7	80				This figure should be kept in SOD. 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: We agree that power generation plays a central role in cost-effective emissions mitigation. That is the point of this whole section. We have rewritten the section to try to be clearer.
9513	7	80	11	80	17	Good figure. Share of electricity is important factor in emission reduction.	Noted
6703	7	80	13			Good figure.	Noted
11954	7	80	13			Question - How much of this is new and not in Chapter 6? Make it clear.	Noted: We have coordinated with Chapter 6 to insure that we do not replicate discussions.
9481	7	80	6	80	9	Suitable sites for renewable energy or CCS are eccentrically-located and installation of them requires great cost. should be added that there are difficulties to make world's average emission factor of electricity to zero.	Rejected: Aggregate costs are discussed in Chapter 6. Specific technology costs are discussed elsewhere in the chapter. Whether or not costs are "great" or not is a judgement. IAMs deploy every technology up to the point at which its marginal contribution to mitigation is equal to the price of carbon.
18106	7	81		81		Clarify how "low-carbon" is defined in the table. Even more helpful would be if the bars were divided into the various low-carbon technologies, e.g. Nuclear and renewables	Accepted: Definition has been added. The split into low carbon options is provided in another figure in the same section.
10576	7	81				No reference given for the figure 7.26 or in text other than "Mitigation studies indicate that..."	The figure summarises results from the AR5 database. Reference is added.
9618	7	81	7	83	3	Please, move here to chapter 6.	The chapter authors are coordinating with Chapter 6.
6560	7	81	9		10	Replace "stable concentrations of CO2 ultimately require emissions to decline to zero" with e.g. "stable concentrations of CO2 require CO2 emissions to peak and then gradually approach zero over more than 1000 years" according to Kheshigi et. al (2005) to make it clear, as the other discussion here is only dealing with issues in this century.	Accepted: This text has been edited to be clearer.
16876	7	83	16		26	Very important point here that if the policies are limited to only advance renewables to lower emissions the cost is much higher than if all technologies are used. This point is buried in the middle of the paragraph and should be moved to front as key point or to the end as a summary statement. In the middle it gets lost. The point is not widely understood and there are many stakeholders who push the alternative view that policy should be only renewables -- the misunderstanding will delay achievement of an agreement and, if we are in a renewables only world, it is possible the rising costs will cause the policy to unravel later.	Taken into account - this important aspect is part of the Chapter 6 discussions.
11955	7	83	2			Consider just showing the figure on the right. The one on the left really adds nothing to the discussion.	Taken into account - comment is obsolete. Figure was removed.
15371	7	83	8			Reference missing ( Luckow, 2012)	Accepted.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10060	7	83	16	84	3	Request to delete the entire section about the Luckow et al paper, as it is misleading and biased. Neither the assumption nor the methodology are transparent, therefore the results of this paper shown in figure 7.29 can not be reproduced. A large number of energy models indicate, that renewable energy systems are cost efficiency by an order of magnitude as opposed to fossil fuel energy systems, especially put 2050. This section is must be seriously rewritten with more and balance informations.	Accepted - Luckow (2012) should be replaced with a citation to Edmonds, J., Luckow, P., Calvin, C., Wise, M., Dooley, J., Kyle, G., Kim, S., Patel, P., Clarke, L., 2012. Can Radiative Forcing Be Limited to 2.6 W/m2 at the end of the 21st Century Without Negative Emissions From Bioenergy and CO2 Capture AND Storage? Climatic Change.
4464	7	84		84		This figure should be redrawn so that the two series in the top plot are joined to their counterparts in the bottom. That is, it should be explicit that both graphs share the same x-axis, even if the break in y-axis is emphasized to give resolution to the other series.	Taken into account - comment is obsolete. Figure was removed.
14548	7	84				The figure needs more explanation.	Taken into account - comment is obsolete. Figure was removed.
16878	7	84				Very good.	Noted.
18645	7	84				Page 84: The discussion on investment needs due to stabilization/mitigation should be related to the needs to invest in the energy system due to other reasons to be meaningful.	Rejected. The discussion of investments focuses here on climate mitigation. Chapter 16 has additional and more detailed discussion of investments.
16877	7	84	13			Suggest addition of the following at end of paragraph: "This implies that pushing the system transition too rapidly via other policy instruments risks substantial short term costs increases which could undermine political support for the policy. This in turn increases the risks of policy reversal, making investors less confident in deploying technologies which require a longer timeframe to earn a return."	Rejected - we recognize that this point might be valid. But the answer is better placed in the policy and framing chapters.
11956	7	84	2			Is this figure from Luckow? If so, needs reference.	Accepted. Citation was updated
6561	7	84	18		19	Firstly, give a reference paper for "The present investment [...] stabilization of GHG". Secondly, specify the level of "stabilization of GHGs" intended ( Category 1?).	Accepted. Reference added, and stabilization level clarified (cat 1)
10094	7	85				annual investment for 2010 is not in line with the info given on page 65. It is also unlikely that for renewables and electricity transmission and storage there is the same number over all 41 scenarios.	Noted. The number is correct and had been taken from the source. We will coordinate internally to improve consistency
18107	7	85				On renewables: "Regulation, Standards" are "essential", not "complement", according to the definition in the text. On the other hand, "Externality pricing" is "compliment" rather than "Essential" for renewables. For nuclear "carefully designed subsidies" are "essential" rather than "uncertain" to mobilise resources - no nuclear power plant in history has ever been built without subsidies.	noted. The policy information was removed from the table
3806	7	85				I have serious concern with the investment cost shown at the Table for Nuclear compared with Renewables. The footnote explanation about what is included in the evaluation is not enough to provide clear information. The Table should be constructed in a way that the reader gets the full information immediately. Thus, what is quoted in footnotes must be part of the Table to avoid incorrect interpretation by readers.	rejected. Footnotes are there to provide details of definitions. The table is transparent as is.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
10577	7	85				Is Category 1 here the same as Category 1 in Fig. 7.21? Maybe this Table and text should be cross-reference to Fig 7.21 (or even placed in section 7.12.1 and merged to avoid confusion). However, having said that, this chapter does not have a section on policies as do other technical chapters. Should it have? This Table 7.6 does cover policies, but appears to be tacked on almost as an after thought. Should there be a section 7.12.7 on policies?	rejected. We can not change or add sections which have been subject to plenary approval at this stage. The policy discussion was removed, since there is an own chapter focusing on policies
10061	7	85				This table has several factual errors: While it states GHG pricing is essential for the development of renewables feed-in tariffs (FIT) are listed under "subsidies". The development of the renewables - especially wind and solar p are entirely driven by FIT, while emissions trading (e.g. ETS) did not result in an RE market so far. Thus, there is no evidence so far, that GHG pricing will be essential for RE in the future. According to the judgment of the European Court of Justice in March 2001 to the German Renewable Energy law, a FIT is not a subsidy. These factual errors must be corrected in table 7.6.	Noted - the policy section of the table was removed.
12334	7	85	20			This is a useful table. Please consider also to put it at the end of the Executive Summary, as it summarises mitigation options, investments needed and policy mechanisms.	rejected. We removed the policy mechanisms as the issue is better placed in the policy chapters
2975	7	85	21			This table is misleading. It states that for the promotion of renewables GHG pricing is key to rapid development, while feed-in tariff and tax credits for R&D or production can complement GHG pricing. However, in reality the opposite could be observed. Feed-in tariffs were key for the innovation and development of renewables. See: Tobias S. Schmidt and others, 'The Effects of Climate Policy on the Rate and Direction of Innovation: A Survey of the EU ETS and the Electricity Sector', Environmental Innovation and Societal Transitions, 2 (2012), 23–48 <doi:10.1016/j.eist.2011.12.002>..	Noted - the policy section of the table has been removed.
9666	7	86				The answer given does not really give a clear answer to the question.	Taken into account - the entire paragraph has been rewritten - together with a reformulation of the FAQ itself.
11957	7	86	19	86	21	This sentence needs to reference what limited examples exist.	Rejected - the Gaps in knowledge summarizes the lack of information concerning the most important questions. It is a summary of the gaps identified during the writing process of the AR5. References therefore are neither needed nor possible due to space constraints.
11958	7	86	23	86	24	What exactly is meant by "integrated decision making support"? Same for "integrated analysis tools". Key word that needs explanation is "integrated". Integrated in what sense? Across disciplines? Policies? Governments? Continents? Regions?	Rejected - Integrated assessments and their usage to support climate policy decision making is a well known concept introduced in chapter 6. It cannot be explained every time it is used.
10280	7	86	30	86	45	FAQ 7.1 will be better to be discussed in Chapter 6.	Taken - into account. The frequently asked question (FAQ) has been reformulated in order to address issues related to the energy supply sector only.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
7747	7	86	30	86	31	Please refer to the Kyoto Protocol	Rejected - the FAQ refers to emissions reduction potentials in the future. The AR5 will be published in 2014. The commitment period of the Kyoto Protocol ended in 2012, the Kyoto Protocol therefore is not relevant anymore within the context of future emission reductions.
2236	7	86	30	86	30	This question does not belong here, as it can only be answered by looking at all GHGs and non-GHG climate forcers, and not just one sector in isolation	Taken - into account. The frequently asked question (FAQ) has been reformulated in order to address issues related to the energy supply sector only.
6462	7	86	30	86	34	Copenhagen Accord does not set the 2 degrees goal, but just "recognized the scientific view".	Taken into account - the Copenhagen Accord has been replaced by the Cancun Agreement.
7748	7	86	32	86	34	Please refer to the Kyoto Protocol and not the the Copenhagen Accord.	Taken into account - the FAQ refers to emissions reduction potentials in the future. The AR5 will be published in 2014. The commitment period of the Kyoto Protocol ended in 2012, the Kyoto Protocol therefore is not relevant anymore within the context of future emission reductions. The reference to the Copenhagen Accord has been replaced by the Cancun Agreement.
4659	7	86	9	86	9	Gaps in the knowledge. The availability of more accurate data cannot be over emphasized. Good inventory information by area is required if plans and investments are to be made for the development of RE, especially biomass. FAO undertook a survey in Ethiopia in 1996 and determined that there were considerable biomass shortages: large-scale planting programs were recommended. However, a detailed inventory was undertaken in 2003, which showed an overall surplus of annual yield compared to demand. It pinpointed areas of shortage and surplus and recommended exploiting surpluses and planting/improved management etc. in shortage areas. (Openshaw, K. 2010b). Without good data information, much investment could be misdirected. (Openshaw, K. 2012).	Noted.
9619	7	86				Please, delete here due to general idea not directly related with chapter 7.	Rejected - comment seems to be misplaced. Please clarify to which part of the text your comment actually refers. 7.13 is about knowledge gaps.
10619	7	86	10			One of the reasons behind gaps in data and information may be the fragmented international regime that deals with energy issues. For example, the International Energy Agency is one of the few international institutions dedicated to energy issues, and yet its membership excludes most of the major fossil fuel producers (e.g., Saudi Arabia) and most of the big emerging consumers (e.g., China, India). See [Colgan, J, T van de Graaf, and R. Keohane. 2012. Punctuated Equilibrium in the Energy Regime Complex. Review of International Organizations. 7(2): 117-143.]	Noted - the section is about gaps, not about the reasons behind them.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18551	7	86	10			Please note that the SRREN also has a comprehensive list of knowledge gaps related to RE (See Ch 1 page 179). These would be useful to incorporate here.	Taken into account - the knowledge gaps have been rewritten by taking into account the information contained in the SRREN.
6562	7	86	30			Define the meaning of "technically feasible".	Taken into account - as the FAQ has been reformulated, the comment is obsolete.
6563	7	86	32		34	Explain how this sentence is correct or give a reference paper, as Chapter 6 and especially Figure 6.29 shows, depending on the technology availability that is complex and uncertain, considerable number of the models used were not able to achieve 450 ppm stabilization by 2100.	Taken into account - the paragraph has been rewritten in order to avoid any inconsistencies with chapter 6.
6564	7	86	33		34	Correct the description "the 2 degrees goal of the Copenhagen Accord", as the heads of state, etc. have agreed on the Copenhagen Accord only "recognizing the scientific view that the increase in global temperature should be below 2 degrees Celsius" but not on "the 2 degrees goal".	Taken into account - the Copenhagen Accord has been replaced by the Cancun Agreement.
6202	7	87	1	87	4	FAQ 7.2 asks whether "Is there a single best solution to achieve deep emission reductions in the energy sector?" The answer addresses supply-side technologies only., and demand-reducing activities seem to be omitted. Suggest adding a new sentence into line 3: " There are also many activities that can improve end-use energy efficiency and thereby reduce the demand for energy and the attendant emissions."	Taken - into account. The frequently asked question (FAQ) has been reformulated in order to address issues related to the energy supply sector only.
6704	7	87	11	87	12	It should be noticed that in order to reduce GHG emission voluntary approach is effective. Recent studies show that voluntary efforts to reduce SF6 emissions by electric power sector in Japan, which have been successfully carried out and will be a good example to show the effectiveness of gas-by-gas sectoral approaches. Moreover, when introducing climate protection policies, it is necessary to consider energy prices so as not to damage family budget.  See: Nishimura et al (2008) Mitigation of Non-CO2 Greenhouse Gases., abstract lines 13-15 <a href="http://criepi.denken.or.jp/jp/kenkikaku/report/detail/Y07012.html">http://criepi.denken.or.jp/jp/kenkikaku/report/detail/Y07012.html</a>	Taken into account- the original FAQ has been reformulated. The comment therefore is obsolete. It is now about barriers and not primarily about necessary policies.
2237	7	87	11	87	12	This answer is far too rigid and prescriptive. IPCC usually does not state in that style of "yes/no". Even if I agree that without strong decisive and long-term stable political framework conditions a low-carbon change in the energy sector will very very likely not happen, there may be other strong forces. If we look at the US for example where cheap gas reduces coal power generation at high speed, without policies, just by economics, similar changes could occur as well. So policy will not be the only driver of change as the current answer implies.	Taken into account- the original FAQ has been reformulated. The comment therefore is obsolete. The FAQ is now about barriers and not primarily about necessary policies.
6203	7	87	11	87	12	"Without intervention, energy systems way will not show a transition to low GHG concentrations. Specific climate protection policies will be necessary in order to achieve that goal." This is incorrect. In some instances, intervention may help in market transitions. In other case it may not be needed, or even hinder transitions. In the U.S., for example, the shale gas revolution is rapidly lowering the carbon intensity of the electric power sector, all without specific intent to produce a specific GHG profile.	Taken into account - the paragraph has been deleted as a consequence of a reformulation of the FAQ.
13209	7	87	24	87	24	Add after renewable "and nuclear"	Taken into account - the paragraph has been deleted as a consequence of a reformulation of the FAQ.

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
9483	7	87	9	87	12	<p>It should be described that GHG emission reduction in energy sector was implemented by voluntary efforts of companies without introducing polices.</p> <p>It should be added that introducing policies can impact civil life and economic activities by rise in the price of energy, and policies need to be decided in full consideration of such impacts.</p> <p>Nishimura et al [1]. introduces voluntary efforts to reduce SF6 emissions by electric power sector in Japan, which have been successfully carried out and will be a good example to show the effectiveness of gas-by-gas sectoral approaches.</p> <p>[1] Mitigation of Non-CO2 Greenhouse Gases  <a href="http://criepi.denken.or.jp/jp/kenkikaku/report/detail/Y07012.html">http://criepi.denken.or.jp/jp/kenkikaku/report/detail/Y07012.html</a>                      [1]abstract lines 13-15</p>	<p>Taken into account- the original FAQ has been reformulated. The comment therefore is obsolete. The FAQ is now about barriers and not primarily about necessary policies.</p>
5967	7	87	9			<p>The need for financial mechanisms to encourage developing economies implment high capitla cost, low-carbon technologies should also be referenced</p>	<p>Taken into account - text revised.</p>
6565	7	87	23		24	<p>Firstly, add "and nuclear" after "renewables". Secondly, replace "a phase out of coal use" with e.g. "further emissions reductions from fossil fuel". Thirdly, explain "a smaller energy system" or give an example.</p>	<p>Taken into account - the paragraph has been deleted as a consequence of a reformulation of the FAQ.</p>
3077	7	88				<p>The paragraph makes strong (and good) statements where bioenergy has or will work and where it does not. I would be worthwhile backing these up by references.</p>	<p>The statements are quite general and are supported by the SRREN, which is cited here.</p>
18647	7	88				<p>Bioenergy annex (page 88) – better to add to the chapter on land use?</p>	<p>A likely way forward.</p>

## Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7

Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response																																																											
4660	7	88		96		<p>. Bioenergy annex. General comments.</p> <p>In my opinion, this annex should start off with the existing potential and actual supply of biomass energy. The net primary production [NPP] of terrestrial plants is an estimated 53.2 Gt carbon, which is approximately 2000 EJ (Melillo et al 1993. Global climate change and terrestrial NPP. Nature, vol. 363 1993. Cited in Openshaw, K. 2011b). This is about half the total NPP of about 4000 EJ, the remaining NPP is from plants in oceans and other water bodies. Every year plants capture this atmospheric carbon and every year it is returned to the atmosphere through respiration, rot, burning and wildfires etc. (The carbon cycle). While a little can accumulate in woody biomass, roots of plants and in the soil, most is lost. Thus, the theoretical potential from terrestrial biomass is an estimated 2000 EJ, but using water-based algae to produce energy is now in the experimental stage; this expands the above estimate.</p> <p>Woody biomass has accumulated over the years in closed and open formations and provides an annual yield, some of which is stored, but most of which is lost. I repeat the table that I gave in my review of chapter 11 AFOLU.</p> <p>Table 1. Land use for the world 2006: units million hectares and 109 dry tonnes of woody biomass<sup>2</sup>.</p> <table border="1"> <tr> <td>World Forest</td> <td>Woodland</td> <td>Arable</td> <td>Grassland</td> <td>Desert</td> <td>Built up</td> <td>Arctic</td> </tr> <tr> <td>14894</td> <td>4021</td> <td>1224</td> <td>1638</td> <td>4170</td> <td>1787</td> <td>298</td> </tr> <tr> <td>100</td> <td>27</td> <td>8</td> <td>11</td> <td>28</td> <td>12</td> <td>2</td> </tr> <tr> <td>543.80</td> <td>450.71</td> <td>9.28</td> <td>79.71</td> <td>0</td> <td>4.10</td> <td>0</td> </tr> <tr> <td>18.35</td> <td>12.44</td> <td>0.36</td> <td>5.33</td> <td>0</td> <td>0.22</td> <td>0</td> </tr> </table> <p>Annual yield</p> <p>Note. 1. Grasslands include wetlands. 2. This is above ground biomass, total biomass is 20-33% more. Annual yield is accessible yield. Total yield is 21.58 x 10<sup>9</sup> t. Carbon content is 50% of dry wood weight. Net [low heat] energy value of dry wood, with a 1% ash content is taken as 18.7 GJ/tonne. Source. FAO 2009 (State of the world's forests [adjusted]) and search of the WWW. Openshaw, K. 2011.</p> <p>Thus, an estimated 18.35 Gt of accessible above-ground woody biomass (343 EJ) could be used every year without reducing the above-ground stock of wood (544 Gt containing more than 10,000 EJ). In contrast, the current consumption of fossil fuels is an estimated 412 EJ (IEA 2011), or 20% more than the annual yield from woody biomass. Of course, other forms of biomass are used for energy, namely crop residues, grass, animal dung, municipal waste, plant oils and grains/sugar to produce ethyl alcohol etc. Also wood and other forms of biomass are used for non-energy purposes. The following is my estimate of the biomass production and its current use.</p> <p>Table 2. 2009: Estimated consumption of energy etc. and annual production of some biomass</p> <table border="1"> <tr> <td>Energy type</td> <td>Energy use EJ</td> <td>Total EJ</td> <td>Annual yield</td> <td>Accessible EJ</td> <td>Total EJ</td> </tr> <tr> <td>Wood products</td> <td>43.6</td> <td>66.01</td> <td>All woody biomass</td> <td>343</td> <td>6152</td> </tr> <tr> <td>Residues/food (food)</td> <td>4.5</td> <td>60.0</td> <td>Residues</td> <td>89</td> <td>-100</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>200</td> <td>+ 603</td> </tr> </table> <p>Dunn 1.5. Grass/forage 67-70 1404</p>	World Forest	Woodland	Arable	Grassland	Desert	Built up	Arctic	14894	4021	1224	1638	4170	1787	298	100	27	8	11	28	12	2	543.80	450.71	9.28	79.71	0	4.10	0	18.35	12.44	0.36	5.33	0	0.22	0	Energy type	Energy use EJ	Total EJ	Annual yield	Accessible EJ	Total EJ	Wood products	43.6	66.01	All woody biomass	343	6152	Residues/food (food)	4.5	60.0	Residues	89	-100					200	+ 603	See above.
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16047	7	88		96		Why this extra annex. I would recommend to write an annex about the Power to Gas-Technology to use the surplus electricity as hydrogen or methan. My opinion is that this will be much more important for the reduction of GHG emission in future.	Forward this comment to the TSU.																																																											
16134	7	88	1	96	32	The annex gives key information on potentials for mitigation. But is it not redondant with some parts of the agriculture-forestry chapter?	Moved to Chapter 11																																																											

**Expert Review Comments on the IPCC WGIII AR5 First Order Draft – Chapter 7**

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7483	7	88	1	96	32	<p>Bioenergy annex. – general comments.</p> <p>In my opinion, this annex should start off with the existing potential and actual supply of biomass energy. The net primary production [NPP] of terrestrial plants is an estimated 53.2 Gt carbon, which is approximately 2000 EJ (Melillo et al 1993. Global climate change and terrestrial NPP. Nature, vol. 363 1993. Cited in Openshaw, K. 2011b). This is about half the total NPP of about 4000 EJ, the remaining NPP is from plants in oceans and other water bodies. Every year plants capture this atmospheric carbon and every year it is returned to the atmosphere through respiration, rot, burning and wildfires etc. (The carbon cycle). While a little can accumulate in woody biomass, roots of plants and in the soil, most is lost. Thus, the theoretical potential from terrestrial biomass is an estimated 2000 EJ, but using water-based algae to produce energy is now in the experimental stage; this expands the above estimate.</p> <p>Woody biomass has accumulated over the years in closed and open formations and provides an annual yield, some of which is stored, but most of which is lost. I repeat the table that I gave in my review of chapter 11 AFOLU.</p>	<p>This is an interesting perspective, and highly valuable. However, I think it would be deeply misleading to start with these numbers. It suggests a perspective where we can start with the theoretical potential and then see how much works. But respiration, rot, burning, wildfires all have their biological and ecosystem function, including water management services for human settlements etc. Too much harm has already been done by single-mindedly focusing on a technology without its context. I think we are much better off starting with the context and that looking with sharp eyes for opportunities that produce a lot of energy while only marginally impacting land carbon, biodiversity and livelihoods, and then see how much we can get together.</p>																																			
7484	7	88	1	96	32	<p>Table 1. Land use for the world 2006: units million hectares and 109 dry tonnes of woody biomass<sup>2</sup>.</p> <table border="1"> <tr> <td>World Forest</td> <td>Woodland</td> <td>Arable</td> <td>Grassland<sup>1</sup></td> <td>Desert</td> <td>Built up</td> <td>Arctic</td> </tr> <tr> <td>14894</td> <td>4021</td> <td>1224</td> <td>1638</td> <td>4170</td> <td>1787</td> <td>298</td> </tr> <tr> <td>100</td> <td>27</td> <td>8</td> <td>11</td> <td>28</td> <td>12</td> <td>2</td> </tr> <tr> <td>543.80</td> <td>450.71</td> <td>9.28</td> <td>79.71</td> <td>0</td> <td>4.10</td> <td>0</td> </tr> <tr> <td>18.35</td> <td>12.44</td> <td>0.36</td> <td>5.33</td> <td>0</td> <td>0.22</td> <td>0</td> </tr> </table> <p>Growing stock Annual yield</p> <p>Note. 1. Grasslands include wetlands. 2. This is above ground biomass, total biomass is 20-33% more. Annual yield is accessible yield. Total yield is 21.58 x 109 t. Carbon content is 50% of dry wood weight. Net [low heat] energy value of dry wood, with a 1% ash content is taken as 18.7 GJ/tonne. Source. FAO 2009 (State of the world's forests [adjusted]) and search of the WWW. Openshaw, K. 2011. □</p>	World Forest	Woodland	Arable	Grassland <sup>1</sup>	Desert	Built up	Arctic	14894	4021	1224	1638	4170	1787	298	100	27	8	11	28	12	2	543.80	450.71	9.28	79.71	0	4.10	0	18.35	12.44	0.36	5.33	0	0.22	0	<p>see above.</p>
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7485	7	88	1	96	32	<p>Thus, an estimated 18.35 Gt of accessible above-ground woody biomass (343 EJ) could be used every year without reducing the above-ground stock of wood (544 Gt containing more than 10,000 EJ). In contrast, the current consumption of fossil fuels is an estimated 412 EJ (IEA 2011), or 20% more than the annual yield from woody biomass. Of course, other forms of biomass are used for energy, namely crop residues, grass, animal dung, municipal waste, plant oils and grains/sugar to produce ethyl alcohol etc. Also wood and other forms of biomass are used for non-energy purposes. The following is my estimate of the biomass production and its current use.</p>	<p>See above.</p>																																			

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7486	7	88	1	96	32	<p>Table 2. 2009: Estimated consumption of energy etc. and annual production of some biomass</p> <p>Energy type Energy use EJ Total EJ Annual yield Accessible EJ Total EJ</p> <p>Wood products 43.6 66.01 All woody biomass 343 6152</p> <p>Residues/food 4.5 60.0</p> <p>(food) Residues 89 -100 200 + 603</p> <p>Dung 1.5 Grass/forage 67-70 1404</p> <p>Waste 0.4 Waste products 1-2 5</p> <p>Total 50.0 126.0 500- 515 1020</p> <p>Unaccounted for: 9805</p> <p>Note 1. Includes an estimated 22.4 EJ for non-energy use in 2009. 2. This includes: inaccessible wood biomass; annual growth of roots; tree leaves; and annual plants on forest floor etc. 3. Not all residues are suitable for use. Food includes animal feed. 5. The annual terrestrial NPP is an estimated 2000 EJ. Therefore, 980 EJ has to be accounted for. It may cover all the 5 groups mentioned in the table. Thus, more NPP may be available for use.</p>	See above.
7487	7	88	1	96	32	<p>The accessible annual NPP is an estimated 500-515 EJ, but these may be minimum figures because some of the unaccounted for NPP may be accessible and useable. This highlights the urgent need for good biomass inventories. However, it also highlights the fact that much more existing NPP could be used for renewable energy purposes, rather than assuming that all additional biomass initiatives have to come from 'new' biomass schemes: this is what the present chapter conveys.</p>	I think here could be a strong point: we need to look sharper at the existing resources for bioenergy.
11959	7	88	1			<p>This is a very interesting section. I would question whether it belongs here or in another Chapter. In this Chapter it appears to give added weight to renewable energy. There is already a preponderance discussion on renewables which raises the question of balance. Decision for the TSU but at written, Chapter 7 could easily be interpreted as arguing for massive substitution of existing energy sources with renewables. CCS is given lip service. In reality the scenarios discussion, which is excellent, and Chapter 6, cover the possibilities rather well. Consider combining and reducing text.</p>	Likely to be moved to Chapter 11.
3076	7	88	15			<p>Why especially starch crops? (This seems like a US perspective)</p> <p>How about oil crops? The latter is very important in the EU (rapeseed), Asian (palm), and South American (Soya) context.</p>	Agreed. For space reasons we don't refer to any specific crops anymore.
12158	7	88	23	25		<p>Its necessary to include also "policy incentives". So, my suggestion is to use..."But policy incentives, advanced technologies and management practices,...".</p>	Is inserted as suggested.
3075	7	88	8	88	14	<p>Focuses on the importance of land management (largely); this is linked to more factors, e.g. institutional framework and governance. I suggest to explicitly make this link.</p>	Considered. One specific sentence on land use (on sugar cane) has been deleted. Instead the following sentence has been inserted: "Success and failure of bioenergy deployment crucially hinges on institutional frameworks and governance. "

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
5742	7	88				<p>When dealing with bioenergy (this comment applies actually to the whole report) there is a lot of work done by the FAO that should be considered. For example, regarding bioenergy iLUC I would suggest to add references to the fact that it is possible tackling this issue through certification and the need for other policy mechanisms, e.g. refer to the RSB/WWF/Ecofys work on low indirect effects certification:  <a href="http://rsb.epfl.ch/files/content/sites/rsb2/files/Biofuels/Working%20Groups/II%20EG/Low%20Indirect%20Impact%20Biofuels%20Certification%20Module%20-%20Field%20testing%20version%20-%20July%202011.pdf">http://rsb.epfl.ch/files/content/sites/rsb2/files/Biofuels/Working%20Groups/II%20EG/Low%20Indirect%20Impact%20Biofuels%20Certification%20Module%20-%20Field%20testing%20version%20-%20July%202011.pdf</a>  <a href="http://rsb.epfl.ch/files/content/sites/rsb2/files/Biofuels/Working%20Groups/II%20EG/RSB%20IIEG%20-%20Certification%20Module%20for%20Low%20Indirect%20Impact%20Biofuels_20110907.pdf">http://rsb.epfl.ch/files/content/sites/rsb2/files/Biofuels/Working%20Groups/II%20EG/RSB%20IIEG%20-%20Certification%20Module%20for%20Low%20Indirect%20Impact%20Biofuels_20110907.pdf</a></p> <p>This builds on the earlier responsible cultivation approach work, which may also be useful info:  <a href="http://www.ecofys.com/files/files/ecofysrcamethodologyv1.0.pdf">http://www.ecofys.com/files/files/ecofysrcamethodologyv1.0.pdf</a>.</p> <p>More generally on ILUC, the Ecofys report prepared for GBEP is relevant:  <a href="http://www.globalbioenergy.org/bioenergyinfo/bioenergy-and-sustainability/detail/en/news/81766/icode/">http://www.globalbioenergy.org/bioenergyinfo/bioenergy-and-sustainability/detail/en/news/81766/icode/</a></p> <p>There is also good work from Winrock, including:  <a href="http://www.globalbioenergy.org/bioenergyinfo/bioenergy-and-sustainability/detail/en/news/82038/icode/">http://www.globalbioenergy.org/bioenergyinfo/bioenergy-and-sustainability/detail/en/news/82038/icode/</a></p> <p>There are also many more, including on ILUC but also other sustainability issues of relevance to the EST report:  <a href="http://www.winrock.org/clean_energy/publications.asp?BU=9054#s600">http://www.winrock.org/clean_energy/publications.asp?BU=9054#s600</a>.</p>	<p>Refer to ILUC policies (certification) in a paragraph in the last section. Cite FAO, prefer peer-reviewed literature when possible. It's difficult for product-oriented certifications to address the macro effect of ILUC adequately. The only product-level certification that seems to address ILUC is the idea of "responsible cultivation areas" in which output of prior services is maintained, but this doesn't conflate the decision to intensify with the decision to produce biofuels. Once intensification is achieved, food could also be planted...</p>
4661	7	89		89		<p>Merge 'traditional' and 'modern' biomass under one heading 'unprocessed biomass'. Exclude charcoal from this heading. It is processed biomass as is biogas, producer gas/water gas (gengas) and liquid products.</p>	<p>Good suggestion. See my suggestion. I prefer linking to GBEP and to whether the biomass is renewable or not. If you leave the two together, you lose the differentiation of unsustainably collected wood.</p>
7085	7	89	17	89	29	<p>The discussion is missing an important overall point regarding the long-term benefits of biomass-based systems based on sustainable forest management principles. It is suggested that at this point in the text, the key finding from the Fourth Assessment Report be repeated - i.e. "In the long term, sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual yield of timber, fibre, or energy from the forest, will generate the largest sustained mitigation benefit". (Fourth Assessment Report, Report of WGIII, Executive Summary)</p>	<p>This section is on climate effects, not an integrated assessment statement that concludes.</p>

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4662	7	89	17	89	17	Stock dynamics. This whole paragraph is very misleading For example: "taking biomass out of forests, includes non-negligible stock dynamics ---". While this may affect individual areas, for the tree population as a whole, it is neutral if only part or all of the NPP is removed. Also, there are many trees outside the forest, which are generally intensively managed and used.	This is a strong statement that we can only consider with supporting literature. RICH: if the ecosystem is approximately in equilibrium including the NPP, how does it remain so if a substantial fraction of NPP is removed? Ecosystems also accumulate C in deadwood, litter, and soil over time. Removing BAU NPP reduces the source for these pools. The only "free lunch" I see is to remove biomass that would otherwise decay quickly. Anders: Please note that the stock dynamic analysis are marginal, e.g the net seq of the forest might exceed emissions, but the marginal seq is lower than the marginal emissions.
3079	7	89	17ff			Include Earles et al 2012, Nature Clim Change, to account also for C changes/fluxes of post use (forest C)	Sounds reasonable. Need to read that paper. RICH: Good point. The Earles paper is very good. Distinction between forest products use in developed vs developing countries is key.
3080	7	89	18	89	20	Make clear that this is true for the outtake of any biomass, living or dead, not only for energy. Regular timber harvest creates carbon debts much "deeper" than bioenergy. This is why we need a correct baseline and a focus on residue material from such operations.	Good point. A comment has been inserted to reflect this.
4663	7	89	18	89	20	"The increased outtake for bioenergy purposes causes a period of increased CO2 emissions [and] carbon debt compared to leaving the forest standing and using fossil fuels ---". This only occurs if the annual tree growth is exceeded or when there is a change of land use from forests to non-forests. Therefore, this statement should be modified.	I think the models of carbon stock dynamics take the annual tree growth into account. RICH: yes, see above. Anders: Also see above. Marginal vs average perspective. In Norway the annual sequestration of forest far exceed any bioenergy emission scenarios, but the marginal emission balance can be negative. E.g shuld we loge one more m3 or not.. that is the question... and the answer is => cabon debt in the short rund but better in the long run.
12914	7	89	24	89	24	Could add reference (Zetterberg, L. Instruments for Reaching Climate Objectives – Focusing on the time aspects of Bioenergy and Allocation Rules in the European Union's Emission Trading System. Ph.D. thesis, department of Earth Sciences, University of Gothenburg, 2011. SE-405 30 Gothenburg. Also available at <a href="http://gupea.ub.gu.se/handle/2077/26672">http://gupea.ub.gu.se/handle/2077/26672</a> . ISBN 978-91-628-8368-3)	What is the additional value of this?
10754	7	89	31	89	31	Change "... generally may be..." to "...is usually..." ?	Considered as suggested.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
2589	7	89	4	89	7	Biomass production from aquatic algae is gaining interest from commercial and R&D institutions	Agreed, but that would be the wrong place to address this. Needs to go into the third part.
3078	7	89	8	89	16	This should be termed "carbon" neutrality (see e.g. Johnson 2009). Paragraph needs revision as the main message is blurry. E.g. the Creutzig et al. Assessment is value and appreciated but should be put in an extra sentence to avoid confusing the two phenomena that (1) biomass was considered carbon neutral in policy; and (2) in climate and economic models assessing policy choices. There are many more (recent) studies which address the full carbon aspect of bioenergy other than Hillier et al 2009; e.g. Mitchell et al 2012 and Hudiburg et al. 2011	This paragraph focuses on climate and economic models not on policies. So I don't see any reason for confusion here. Also it should be climate neutrality, not carbon neutrality, because albedo effects are not related to carbon cycles. Citing good studies can be improved, yes. RICH: Also, carbon neutrality (zero net change in C over time) does not imply climate neutrality, as we wrote here.
6224	7	9	1	9	3	This statement requires expansion and justification.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
16094	7	9	10			Use of the word "recycling" to describe chemical reprocessing of nuclear waste is problematic. In France, the only country in the world to have the full cycle of reprocessing, actual use of waste materials amounts to only a few percentage points according to NGOs, and 12% according to the official Haut Comité à la Transparence et à l'Information sur la Sureté Nucléaire ( <a href="http://hctsin.fr">http://hctsin.fr</a> ) in a 2010 report. It is a far cry from the 96% claimed by the French firm AREVA.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
18196	7	9	11		15	Add to paragraph: Renewable energy sources provide currently small a growing contribution to global heat and electricity supply, and but are the most rapidly increasing. Costs, as well as social and environmental barriers, are restricting this growth. Smaller-scale, distributed energy plants using local energy resources and low or zero-carbon emitting technologies, can give added reliability, be built more quickly and be efficient by utilizing both heat and power outputs locally. defined by traditional energy accountability methods , as well as social and institutional barriers, are yet restricting the widespread use of renewable energies, which depends more on the internalization of "externalities" , than on other well known factors. Comments (accountability methods): The energy accounting was created to be used with conventional sources and adapted to their characteristics and not to the traits of renewable energies (RE), which require the consistent use of life cycle costs, the practical recognition of their potential continuous availability (which contrasts with the exhaustible fossil fuel reserves) and other specific methods. Comments (externalities): Meaning the specific value of RE from an environmental, land use and social standpoint, usually called "externalities" with respect to the energy process.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
18197	7	9	11		15	Alternative paragraph: Renewable energy sources provide currently a growing contribution to global heat and electricity supply, and are the most rapidly increasing. Costs, defined by traditional energy accountability methods, as well as social and institutional barriers, are yet restricting the widespread use of renewable energies which depends more on the internalization of "externalities" , than on other well known factors.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
9631	7	9	11	9	12	Was RE the most rapidly increasing energy source when AR4 was written?	Taken into account - comment is obsolete. Overview of AR4 was deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18043	7	9	11	9	12	The term "small" is misleading, not to say incorrect, and in contradiction with the findings in the following pages. According to table 7.1 page 12, renewables is 13.3% of primary energy consumption; nuclear is 2% and gas 21.5%. In terms of electricity supply, renewables is 19.5%; gas is 13.5%; nuclear is around 14%. It would be difficult to argue that renewables provide a "small" contribution, relative to other technologies.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
6172	7	9	11	9	12	"Renewable energy sources ... are the most rapidly increasing" is ambiguous. As presented here, it sounds as though the increase is referring to an increase in MW capacity. However, more likely it is referring to the percentage increase, where the capacity additions for renewables is applied to a much smaller base.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
17360	7	9	11			currently a small contribution...	Taken into account - comment is obsolete. Overview of AR4 was deleted.
15941	7	9	11	9	11	is 20% of global electricity supply (from renewables) 'small'?	Taken into account - comment is obsolete. Overview of AR4 was deleted.
2582	7	9	12	9	12	Renewable energy cost effective compared to conventional (except energy from coal). In many countries electricity from wind energy is far below grid parity. Electricity from Photovoltaic reached in few countries the grid parity.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
6795	7	9	13	9	15	"Smaller-scale, distributed energy plants using local energy resources and low or zero-carbon emitting technologies, can give added reliability, be built more quickly and be efficient by utilizing both heat and power outputs locally." In reviewing the special report on renewable energy I cited what I felt was a bias towards distributed generation as opposed to central generation, and I fear there may be a similar bias here. We need both distributed and central generation from carbon-free sources to have any chance of significantly addressing the climate change problem. Each of these has advantages and disadvantages. As just one example, nuclear plants can provide baseload power and directly replace coal plants.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
16779	7	9	14			suggest insert after "zero-carbon emitting technologies" the following "frequently are disadvantaged from economies of scale impacts."	Taken into account - comment is obsolete. Overview of AR4 was deleted.
16780	7	9	14			suggest insert after "can give added reliability" the following: "when integrated with existing energy systems." This is the context w/in which I most frequently encounter this claim -- few claim that reliability is enhanced by being off grid nor are there studies that I know of that have proven this point.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
18198	7	9	16		25	Add to paragraph: No single policy instrument will ensure the desired transition to a future secure and decarbonized safe, fair and balanced world. Policies will need to be regionally specific and both energy and non-energy co-benefits as well as social acceptance and technological risks should be taken into account based on sound science and economic analysis. Energy sector reform is critical to sustainable energy development and includes reviewing and reforming subsidies, establishing credible regulatory frameworks, developing policy environments through regulatory interventions, and creating market-based approaches such as emissions trading on the real value of natural resources For developing countries, particularly oil importing countries, lack of security and higher world-energy prices constrain endeavors to accelerate access to modern energy services that would help to decrease poverty, improve health, increase productivity, enhance competition in the frame of human solidarity and integration and thus improve their economies.	Taken into account - comment is obsolete. Overview of AR4 was deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18199	7	9	16		25	Alternative paragraph: No single policy instrument will ensure the desired transition safe, fair and balanced world. Policies will need to be regionally specific and both energy and nonenergy co-benefits as well as social acceptance and technological risks should be taken into account based on sound science and economic analysis. Energy sector reform is critical to sustainable energy development and includes reviewing and reforming subsidies, establishing credible regulatory frameworks, developing policy environments through regulatory interventions, and creating marketbased on approaches to the real value of natural resources for developing countries, particularly oil importing countries, lack of security and higher worldenergy prices constrain endeavors to accelerate access to modern energy services that would help to decrease poverty, improve health, increase productivity, enhance competition in the frame of human solidarity and integration and thus improve their economies.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
5150	7	9	16		17	As long as the heavens are free for all to put ghg in we will have a "tragdy of the commons"-situation - setting a price on carbon or ghg emissions may be a "silverr bullit" - or so many insitutions of the world indicate - the sentence here seems to omit the main problem, that emissions is more or less "free"	Taken into account - comment is obsolete. Overview of AR4 was deleted.
6695	7	9	19	9	22	It should be noticed that voluntary approaches are indispensable for energy sector reform rather than regulary inteventions and creating market based approaches. Recent studies show that the Japanese steel industry responded to the Kyoto target by launching a voluntary action plan in 1996 a year prior to the adoption of the Kyoto Protocol with challenging quantitative target: 10% reduction of energy consumption in 2010 compared to 1990. Since then, the steel industry has made stead progress toward achieving these goals. As a result, the energy consumption in 2008 was 11.5% less in comparison to the 1990 level (equivalent to 12.1% reduction in CO2 emissions).  See: Teruo Okazaki, Mitsutsune Yamaguchi (2011) Accelerating the transfer and diffusion of energy saving technologies steel sector experience—Lessons learned Original Research Article Energy Policy, Volume 39, Issue 3, March 2011, Pages 1296-1304 <a href="http://www.sciencedirect.com/science/article/pii/S0301421510008827">http://www.sciencedirect.com/science/article/pii/S0301421510008827</a>	Taken into account - comment is obsolete. Overview of AR4 was deleted.
9989	7	9	19	9	22	Energy sector reform should include "voluntary target scheme" because 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 No63 line of this table. On the other hand, market-based mechanism such as emission trading has several problems. Volatility of emission permit prices affects volatility of product prices as evidenced by fluctuating price developments in the EU-ETS. Therefore, the market-based policy tools of cap-and-trade cannot provide credible incentives for the technological change, as described in (Montgomery, 2005, abstract) and (Baldursson, 2009, page29). These literatures are listed in the No62 line of this table. In addition, CO2 leakage caused by the implementation of the ETS happened actually through international transfer of industry , as shown in (Rosendahl, 2011, abstract), (Aichele, 2012, page336), and (Peters, 2011, page1). These literatures are listed in the No50 line of this table.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
9367	7	9	19	9	22	It should be deleted because regulatory interventions are not necessarily needed. In Japan the voluntary action policy does work successfully in the industry sector.	Taken into account - comment is obsolete. Overview of AR4 was deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
16781	7	9	21			This "creating market-based approaches such as emissions trading" appears almost as an afterthought. Insofar as this is a key point of negotiation for some, could more effort be made to discuss how this impacts or interacts with the energy system, how it is likely to respond?	Taken into account - comment is obsolete. Overview of AR4 was deleted.
15354	7	9	22			Perhaps it would help to be clear that security being referred to is energy security as can be confused with other forms of security related to e.g. political unrest	Taken into account - comment is obsolete. Overview of AR4 was deleted.
2256	7	9	22	28	14	By far the most useful section of the whole report	Noted.
18044	7	9	22	9	22	add "or carbon taxation". In economic terms, an instrument based on quantities (emissions trading) is no more "market-based" than one based on prices (taxation).	Taken into account - comment is obsolete. Overview of AR4 was deleted.
6173	7	9	28			While the concerns of differing data gathering methodologies are valid, it's strange to bring it up here and not revisit it. Why point it out and then immediately start mixing and matching IEA and DOE sources? Issues like this are best addressed in a methodology section or chapter.	A reference to the Methodological Annex is made where the issue is dealt with. The point is raised here to make readers aware to energy data differences from different sources.
18501	7	9	28	9	28	What is the IPCC's approach to deal with these different statistical sources? Have we selected one data set to use over the others? If so, why?	This is dealt with in the Methodological Annex. It is specified in the caption to figure 7.1 and in the note to the table 7.1
17206	7	9	29			The numbers are misleading. Keep to the standard of energy accounting chosen for AR5.	We are assessing the literature. There are different numbers in different sources. And this disagreement deserves mentioning
17747	7	9	3			give a reference for 20US\$/ton CO2	Taken into account - comment is obsolete. Overview of AR4 was deleted.
5942	7	9	3			The value of \$20/t at which a large mitigation potential of low carbon technologies is reported to exist should be qualified to specify whether it applies to variable RE technologies and if so whether it includes the cost of backup	Taken into account - comment is obsolete. Overview of AR4 was deleted.
2822	7	9	33	9	35	Lumping together unconventional fuels with renewables, as in this sentence, is misleading – they do not have the same implications for diversity (or emissions).	The statement is correct. It does not sum them up. It just points on growing trends.
12588	7	9	4			Should it be mentioned that we actually need petroleum products for the production of renewable energy systems? Plastics, rubber etc.	Taken into account - comment is obsolete. Overview of AR4 was deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
18194	7	9	4		11	Add to paragraph: Conventional oil reserves will eventually peak, but it is uncertain exactly when and what will be the nature of the transition to alternative liquid fuels. Conventional natural gas reserves are larger by scale, but less evenly un evenly distributed across regions. Unconventional oil and gas resources are abundant, with uncertain future for the scale of their economic development (IEA, 2012). More reliance on coal will demand viable CCS (Comment) technologies if GHG emissions from its use are to be limited. There are many barriers for nuclear energy to contribute more to GHG mitigation: longterm fuel resource constraints without recycling; economics; real costs (Comment) safety; waste management; security; proliferation, and adverse public opinion. Comments (CCS): Some research about Carbon Capture and Use-CCU, have already started. This could be a more practical solution than CCS. Comments (real costs): Including whole decommissioning, decontamination and alternative land-use costs, and also the updated costs of the latest technology and safety.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
18195	7	9	4		11	Alternative paragraph: Conventional oil reserves will eventually peak, but it is uncertain exactly when and what will be the nature of the transition to alternative fuels. Conventional natural gas reserves are larger by scale, but un evenly distributed across regions. Unconventional oil and gas resources are abundant, with uncertain future for the scale of their economic development (IEA, 2012). More reliance on coal will demand viable CCS technologies if GHG emissions from its use are to be limited. There are many barriers for nuclear energy to contribute more to GHG mitigation: long-term fuel resource constraints without recycling; economics; real costs safety; waste management; security; proliferation, and adverse public opinion.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
9630	7	9	4	9	7	If this is a summary of AR4, why is IEA, 2012 being referred to? I agree with the statement, but was it the same in AR4?	Taken into account - comment is obsolete. Overview of AR4 was deleted.
4101	7	9	4	9	4	I assume "Recoverable conventional oil reserves ..." is meant.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
6170	7	9	4	9	4	"Conventional oil reserves will eventually peak ..." is a misleading way to begin the paragraph. As much of the subsequent discussion makes clear, unconventional reserves are accounting for an increasingly larger share of total production, in some cases over half. See p. 40, line 30. In this context, talk about "peak production" for a portion of the total production makes no sense, suggesting looming market crises that may or may not emerge.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
16777	7	9	4			Why say "Conventional oil reserves will eventually peak" knowing that many people believe this is true and a harbinger of either salvation (lower emissions) or disaster (run out of oil)? Within this chapter, in section 7.4, there is a discussion that at first seems to indicate we have a peak oil problem, but then completely refutes the point with a very sound discussion of resource economics and the fact there are huge supplies from more costly sources that become attractive to exploit as the lower cost supplies are exhausted and prices increase. Peak oil is only true if confined to discussing particular price ranges, as in "we are likely to run out of oil that is economic to exploit at market prices below \$20/barrel". This chapter could be greatly improved if the debate held on the pages was clarified.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
16778	7	9	4			Perhaps you can begin this discussion by simply noting the following: Nearly all energy sources involve constraints or have associated trade-offs.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
11916	7	9	40			"to 14%" from what? Say what it was.	Taken into account - comment is obsolete. Underlying text has been deleted.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
17208	7	9	44	10	2	Gas flaring (CO2 and black carbon) and methane emissions, both, from the extraction sector should be noted. The corresponding emissions could be reduced and also produce valuable energy carriers.	This section does not discuss emissions yet.
3776	7	9	6	9	6	"but less evenly distributed across regions". Please, clarify the meaning of "less". You refer to "less" than conventional oil reserves? Is this true?	Taken into account - comment is obsolete. Overview of AR4 was deleted.
6171	7	9	7			This section described as a summary of the last AR. How can a source from 2012 be referenced?	Taken into account - comment is obsolete. Overview of AR4 was deleted.
11761	7	9	8	9	11	It seems that AR4 doesn't say such. Since this section is summary of AR4, what doesn't include in the AR4 shouldn't be added.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
9502	7	9	8	9	12	Only the disadvantages of nuclear power were summarized from AR4, The text on AR4 chap7 executive summary "Nuclear energy, already at about 7% of total primary energy, could make an increasing contribution to carbon free electricity and heat in the future" should be written on this section.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
6761	7	9	8			It should be described that nuclear energy contributes to economic competitiveness and CO2 emission reduction. Because I referred to IPCC Fourth Assessment Report, Working Group III Chapter 4, page 269, column 1, line 28 [1].  [1] <a href="http://www.ipcc-wg3.de/publications/assessment-reports/ar4/.files-ar4/Chapter04.pdf">http://www.ipcc-wg3.de/publications/assessment-reports/ar4/.files-ar4/Chapter04.pdf</a>	Taken into account - comment is obsolete. Overview of AR4 was deleted.
11000	7	9	19	9	22	It is stated that regulations or market-based approaches such as emission trading is important in energy sector reform, but it should be also noted that there are countries like Japan whose voluntary approaches function effectively.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
11915	7	9	28			Need to be careful. Different sources count different things, e.g., lower vs higher heating values, and some don't include traditional biomass, so often these are not uncertainties, just different ways of counting, and even converting.	That is why reference is made to the Methodological Annex.
7117	7	9	28			The sentence lacks clarity	It just says the data from different sources are not strictly comparable.
12319	7	9	26			Please consider to include emission of SF6 from electric transmission systems in this section. The other parts of this section could be shorter. Maybe some of the details could be moved to an appendix or just shown in graphs/figures.	Rejected - This section is not on emissions, but on energy use.
7019	7	9 of 135	12	9 of 135	12	Add "without externalities" after the word "Costs", at the beginning of the final part of line 12, because if externalities would be taken into account, the result would be very different.	Taken into account - comment is obsolete. Overview of AR4 was deleted.
10755	7	90	1	90	8	It could be mentioned what the response of burning biogenic CO2 is in terms of GTP (i.e. that cooling for a period is calculated).	Don't understand what it means. No problem. The GTP is a different metric than GWP. This is an important point. What he says is that the instant temperature change profile of biogenic CO2 emissions actually has a period of cooling before it tends to zero. While fossils warm for millennia. We will bring it into the text.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4665	7	90	18	90	19	. "Other non-first-generation bioenergy crops such as --- Miscanthus sp. require minimal or zero N fertilization ---". All non-nitrogen fixing species require N fertilization to maintain productivity, this applies to Miscanthus sp., switch grass, Jatropha sp., oil palm etc. For Miscanthus sp., 70-75 kg/ha of N fertilizer are required to maintain a yield of 14-15 dry tonnes of grass.	This is an important point, we need to look at in more detail. Opinions differ on how much N is required (which is different from how much will be applied if economic). Scown et al 2012, doi:10.1088/1748-9326/7/1/019502 (p. 5-6) presents alternative views.
11376	7	90	23	90	35	Natural aerosols from boreal forests should also be mentioned as a potentially important climate forcer (see e.g. Tunved et al. Science 14 April 2006: Vol. 312 no. 5771 pp. 261-263. DOI: 10.1126/science.1123052). The high uncertainties concerning all the geophysical impacts of forests could be emphasized. Besides, when considering the whole bioenergy chain, black carbon originated from biomass combustion must not be forgotten as a factor influencing the surface albedo especially in the arctic.	That is reasonable. We should add one sentence. But we should also note that Organic Carbon co-emitted with BC exerts negative forcing. Unclear how it balances out. Jacobson @ Stanford has written on this.
4666	7	90	33	90	33	Line 33. Replace 'slow' by 'long'.	Slow is appropriate here. An alternative is "long rotation period" but that mean to have another word here.
11380	7	90	33	90	35	The question of advantage/disadvantage of short/long rotations is in connection to bioenergy somewhat irrelevant as industrial wood demand is usually the driver for harvesting. In energy wood harvest there is rather a choice whether in addition to industrial wood harvest to collect the residues (branches, crown, stumps) or not. Thus the relevant question is: what is difference in albedo and carbon balance between the cases of totally cleared harvest site vs. cleared site except that residues are left.	Not sure. What do others say? I read this as a particular case of estimating delta from BAU, which he assumes includes industrial wood harvesting. So the bioenergy case involves only the residues. With that baseline, I agree with him. It will be difficult to squeeze this in, though... It is well understood that industrial wood is the economic driving force for forestry activities today. In situations where no whole stem fractions are used for bioenergy, resources for bioenergy boils down to residues and stumps. This is though addressed in the carbon dynamics part. We say that residues have short carbon paypack times.
5237	7	90	35			More site specific information confirming this statement can be found in: LOHILA, A., MINKKINEN, K., LAINE, J., SAVOLAINEN, I., TUOVINEN, J.-P., KORHONEN, L., LAURILA, T., TIETÄVÄINEN, H., LAAKSONEN, A. 2010. Forestation of boreal peatlands – impacts of changing albedo and greenhouse gas fluxes on radiative forcing. J. Geophys. Res., 115, G04011, doi:10.1029/2010JG001327.	Anders: We can add this reference.

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3081	7	90	37	90	39	Depends on more than 2 factors: The type of biomass used (green tree vs. harvest residues vs. insect/disease affect trees) (Lamers et al 2012); Prior land use (Fargione et al. 2008; Lapola et al. 2010; Don et al. 2011); Sequestered carbon volume in the soil and plant stock prior to harvest (depending on biome, tree species, forest age structure) (Harmon et al. 1990; Bernier and Paré 2012), in combination with harvesting intensity i.e. outtake/harvest level (Mitchell et al. 2012); Plant (re-) growth rates (influenced by site-productivity and management practices) (Cherubini et al. 2011), and rotation cycles (Mitchell et al. 2012); Carbon dynamics on the site (longer payback for cold climate and coarse material) (Bernier and Paré 2012); Wood use: (1) efficiency of usage and (2) additional emissions for converting biomass into energy and non-energy products, (3) carbon emission rates and efficiency of the respective products replaced (Marland and Marland 1992; Schlamadinger and Marland 1999; Mitchell et al. 2012)	No disagreement, the 2 factors summarize the more detailed list of factors here. Also these detailed list is mostly covered in the previous section. RICH: Agreed.
4667	7	90	38	90	39	Most of the wood harvest systems, be they from natural forests, plantations or farm trees etc. will not cause a land use change. New planting may be in degraded areas and therefore, there should be an increase in sequestered CO2.	Unclear how one can say "most" here. I'd say "some" is more appropriate. In any case what existed before the planation? What replaces the natural forest? I don't believe any action is required here.
11378	7	90	39	90	39	Add sentence to the end: The efficiency of the bioenergy system in displacing emissions compared to the fossil one can be characterized by the so-called displacement factor (Marland and Schlamadinger 1997).	Too technical.
5236	7	90	4			Please, for new information add the references: Pingoud, K., Ekholm, T., Savolainen, I. Global Warming Potential (GWP) factors and warming payback time as climate indicators of forest biomass use". Mitigation and Adaptation of Strategies for Global Change (3 November 2011), pp. 1-18. DOI 10.1007/s11027-011-9331-9 2. Helin, T., Sokka, L., Soimakallio, S., Pingoud, K., Pajula, T. 2012. Approaches for inclusion of forest carbon cycle in life cycle assessment – A review. GCB Bioenergy (in press).	Anders: They are mixing scenario analysis and characterization factor development. Their approach is not consistent with WGI definitins of metrics and their intended applications.
11379	7	90	42	90	42	Add sentence after "...markets.". As a consequence of the market or rebound effects the effective displacement factor is lower than the theoretical one.	We need a broader discussion on the rebound effect. Ask TSU where they see it.
4668	7	90	43	90	43	What is LCA?	Noted, consideration under discussion.
4664	7	90	5	90	6	---"a biogenic CO2 emission pulse generates radiative forcings in timescales equivalent to regrowth periods ---". This is only considering individual trees or individual areas. The dynamics of the whole population in the area have to be considered and therefore, the 'relative forcing' may be negligible or even negative!	This statements assumes that the removal of carbon stock at one place is compensated by increased uptake somewhere else. I cannot follow this logic. This is a classical landscape vs single stand discission. We have a new paper forthcoming bridging this. His take is that the net flux is zero if the stock across the landscape level remains constant. e.g no net flux if $dStock/dt = 0$

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
11377	7	90	8	90	8	Add sentences: Using GWP or other radiative forcing or temperature based metrics, emission factors for harvest-residue-based bioenergy can be estimated in proportion to the business as usual baseline where residues are left on site (Pingoud et al. 2012). In case the time interval of interest is fixed, the emission factor could basically integrate the climate impact of the dynamic carbon debt and all the non-ghg climate forcers into a single CO2 eq number. Reference: Pingoud, K.; Ekholm, T.; Savolainen, I. 2012. Global warming potential factors and warming payback time as climate indicators of forest biomass use. Mitigation and Adaptation Strategies for Global Change 17: 369–386. Springer. doi-link: 10.1007/s11027-011-9331-9	That is interesting, can we get this into one single sentence? On the other hand, I am worried that we get too much into detail; we need to shorten rather than getting longer. They are mixing scenario analysis and characterization factor development. Their approach is not consistent with WGI definitins of metrics and their intended applications.
12915	7	90	8	90	8	The establishment of new forest or energy crops on fallow land may both build up new carbon stocks, thus having a negative radiative forcing, and provide bioenergy.	To be integrated, see also AF's comments. Crucial to not ignore informal land rights. depends on land use history. There may not be much soil C seq unless the land was recently cropped. Also, if in the baseline the land would return to production relatively soon, using it for energy crops could be food-competitive and trigger ILUC. The comment is valid. But it is very case and context specific.
6922	7	90	23	90	35	Ensure consistency and avoid overlap with WGI AR5, Chapters 2/6/8 and the WGI assessment of the physical science basis of changes in land cover etc. on radiative forcing.	could shorten the text and refer to these chapters, but I haven't seen the WGI documents. Do not have latest version, but could not see overlap of concern in a previous version. (Please get hold of recent documents so we can ensure this.)
18648	7	91				Page 91: A rebound effect of bioenergy on the use of fossil fuels is discussed. The problem is in reality the same for other sorts of renewables, efficiency measures as well as fuel shifts so there is no reason to couple the challenge to biofuels. It just shows that a single policy or action will not handle the problem, that there is a need for policy packages. As indicated there are means to handle rebound effects.	Agreed. it's still not clear to me how taxing in the policy region affects macroeconomic rebound effects. Agree with the comment made.
4669	7	91	1	91	3	"Biospheric C losses --- can be in some cases more than 100 times larger than the annual GHG savings ---". These are extreme cases, generally, the GHG savings are much larger, and in most cases substantially larger than the C losses. This statement denigrates tree planting and management.	Literature needed here.
13301	7	91	26	91	48	I agree that this section should be moved to somewhere else, and should broaden the rebound effect discussion in this context, it should also cover the downward pressure on coal prices that would result from mitigation scenarios, in addition to the equivalent situation for oil	If moved somewhere else, we should ensure that fuel market effects are covered, not just efficiency. Agree to move displacement effects out of this chapter. These issues are valid for all systems and shuld be adressed generally.

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2853	7	91	26	91	48	Although I believe the bioenergy annex could be shortened or relocated, the issue of rebounds does, as suggested here, deserve systematic discussion and this should of course include efficiency rebounds. More generally, the impact of all the various options at system level needs consideration.	Agreed about need for system discussion for all mitigation strategies. see above line.
3082	7	91	26	91	38	It is fair to point out this discussion, but we should still remain aware of the dimensions. So far modern bioenergy constitutes a marginal fraction as compared to fossil fuel; this is true to liquids compared to oil as well as solids compared to e.g. coal. The economic discussion is therefore largely theoretical. To my knowledge, it has not yet been proven empirically in any study that e.g. wood pellet consumption in the EU has lead to a change in (regional, EU, or even global!?) coal consumption or prices.	Exactly that is the point: If coal consumption etc. doesn't go downward, bioenergy is supplementary not complementary to fossil fuels. yes, see York, 2012 Nat. Clim. Change doi: 10.1038/nclimate1451: The problem is the policies to support effective substitution are not in place. That is the problem ...not the technology.
3646	7	91	26	92	4	Move to Chapter 5.9.2.	Noted, consideration under discussion.
3807	7	91	4	91	6	Please, consider reading Pacca and Moreira, 2011 paper. - Pacca, S. and J. R. Moreira, 2011. A Biorefinery for Mobility? Environ Sci Technol. 2011 Nov 15;45(22):9498-505.	Noted, consideration under discussion.
17380	7	91	48			be avoided by cap...	Is related to the rebound thing.
4670	7	92	10	92	10	"Around 2.7 billion people relied on [traditional] biomass in 2008". This figure is an underestimate, even for household cooking. Wood and other forms of [traditional] biomass are used for heating, especially in northern latitudes. It is also used by the service sector and formal and informal industries for cooking, warming and to provide process heat, especially in developing countries.	Of no help, if no better literature is provided.
4671	7	92	15	92	16	'--- reducing both black carbon and CO2 emissions by 60% ---.' The main causes of black carbon are: wild fires and emissions from vehicles. I agree that improved biomass devices should be a major push to improve the health of the users and reduce energy consumption for particular tasks. But, clearing the forest floor of debris and using it for energy may prevent many wild fires and provide a useful raw material. Also, black carbon and biochar help to improve the productivity of the land. Soot could be collected from chimneys and spread on the land and it may be cheaper than producing biochar.	Ok. Let's try to integrate this comment, very briefly.
4672	7	92	15	92	16	"Co-benefits accrue from improved indoor and local air quality and time savings for those collecting fuelwood, typically women and children ---". Fuelwood is not only collected for own use, but for sale.	Good point.
3808	7	92	16	92	16	Please, consider reading Pacca and Moreira, 2011 paper. - Pacca, S. and J. R. Moreira, 2011. A Biorefinery for Mobility? Environ Sci Technol. 2011 Nov 15;45(22):9498-505.	Sounds reasonable. Need to read that paper.
7086	7	92	20	92	21	As support for the statement "...the health and environmental gains from collection and proper management through combustion or anaerobic digestion can be significant you could cite Gaudreault ,et. al. (2012). Life cycle greenhouse gas and non-renewable energy benefits of kraft black liquor recovery. Biomass and Bioenergy, <a href="http://dx.doi.org/10.1016/j.biombioe.2012.06.027">http://dx.doi.org/10.1016/j.biombioe.2012.06.027</a> .	Sounds reasonable. Need to read that paper.
13302	7	92	22	92	39	For the long-term (e.g. 2050), given high expected carbon prices and constrained biomass availability, it is useful to frame the argument around where bioenergy should be used in terms of the quantity of abatement derived from using a tonne of biomass in different applications. By doing this one can incorporate bioenergy with CCS into the same analytical framework as uses that simply displace fossil fuel consumption (and also with non-energy uses, such as using wood as a construction material). Using this framework, bio CCS provides greater abatement than most other uses, primarily due to the high carbon content of solid biomass relative to other fuels (e.g. natural gas) - see Chapter 4 of <a href="http://www.theccc.org.uk/reports/bioenergy-review">http://www.theccc.org.uk/reports/bioenergy-review</a> for a grey literature version of such analysis	CCS is discussed somewhere else in Ch. 7. Need to refer to this.
10757	7	92	26	92	26	What is meant by "... lower GWP effects..." ? This should be reworded.	Specify better. Same as above.

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17381	7	92	36			sugar stream goes...	Is corrected.
3013	7	92	36			It is written bioproducts. Please fix it.	Thanks, Is corrected.
17757	7	92	37			delete the words "Carbon capture and storage (CCS) of" - these do not fit here	I disagree. I think we should add references, though, e.g., doi: Rhodes & Keith, 2005, 10.1016/j.biombioe.2005.06.007
4673	7	92	37	92	39	CCS. Surely it may be much cheaper to pursue CCS directly in tree sequestration, rather than by capturing the CO2 emission from bioenergy plants and storing it underground? See my general comments above about CCS.	Reference?
5745	7	92	45	92	46	"Aquatic biomass, i.e. microalgae can offer productivity levels above those of terrestrial plants" This statement is not correct according to Prof. Tredici and FAO report on algae-based biofuels 2010, because the photoefficiency seems to be comparable with C4 plants and well watered C4 plants don't produce less biomass than algae.	The suggestion forgets that the algae do not have all the vascular tissue for plant support that the C4 plants have. The reference of Ch 2 is sound for this.
10756	7	92	6	92	6	What is meant by "... provide significant GWP benefits,..." ? This should be reworded.	True. The statement is only correct with additional conditionalities that e.g. avoid rebound effects. The thing here is terminology. Jan is a metric guru. GWP is a well defined climate metric. The use of this in some sentences in the manuscript is not in line with WG I definitions. See Previous 4AR WGI reports on metrics chapters.
5739	7	93	1	93	2	A similar conclusion can be found in the FAO report on Algae-based biofuels - Applications and co-products ( <a href="http://www.fao.org/docrep/012/i1704e/i1704e00.htm">http://www.fao.org/docrep/012/i1704e/i1704e00.htm</a> )	Add the reference
4674	7	93	11	93	11	"Biofuels include ethanol and biodiesel ---". Methanol should not be neglected, neither should liquid products from gengas.	Ok.
4675	7	93	12	93	12	Primary resource management. The most important primary resource management output has been neglected, namely improved tree management and increased use of NPP from existing woody growing stock.	Is covered in the forestry section.
5740	7	93	22	93	22	IRENA reports even larger variation from 8 to 400 EJ by 2050.	Noted, consideration under discussion.
4676	7	93	22	93	22	"--- with global estimates ranging from 25 to more than 200 EJ/yr in 2050 (Table 1 – Ch 11)". I think this is Table 11.3! However, this table is difficult to follow at present.	Not helpful. What are better references?
17382	7	93	24	93	25	(e.g., animal feeding) or if soil...	Is corrected.
3083	7	93	29	93	37	Please consider my comment No7: there are many options to create bioenergy benefits from forestry. It depends on the context, i.e. feedstock, alternative land and harvest use, etc. (see No7 for details).	Ok. Let's try to integrate this comment, very briefly.
11381	7	93	29	93	37	An extensive list of climate forcers associated with forests should be given. Relevant references needed.	Read his paper, and see. a reasonable point. I emailed Kim to ask for references.

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Comment No	Chapter	From Page	From Line	To Page	To Line	Comment	Response
4677	7	93	31	93	33	“Biomass potential estimates range from 0-100 EJ/yr in 2050. Realizing higher-end potentials --- implies increasing the forest output to several times the present global industrial roundwood production ---”. Conventionally, roundwood production is divided between ‘fuelwood’ and ‘industrial roundwood’. Fuelwood is the largest percentage. This phrase should be changed to ‘global roundwood production’. However, in Table 2 above, the potential accessible wood energy is an estimate 343 EJ/yr, much larger than the maximum of 100 EJ quoted above. Therefore, in my opinion, the potential with increased plantings could be in the range of 250-300 EJ from wood alone.	the 343 EJ/yr estimate, to my best understanding, is a theoretical one, and doesn't respect ecosystem functioning, see above.
5238	7	93	37			Site specific information confirming this statement can be found also in: LOHILA, A., MINKKINEN, K., LAINE, J., SAVOLAINEN, I., TUOVINEN, J.-P., KORHONEN, L., LAURILA, T., TIETÄVÄINEN, H., LAAKSONEN, A. 2010. Forestation of boreal peatlands – impacts of changing albedo and greenhouse gas fluxes on radiative forcing. J. Geophys. Res., 115, G04011, doi:10.1029/2010JG001327.	Sure, it's a slightly older source still post-AR4.
2590	7	93	38	96	32	The text does not consider the new generation of biofuels: its potential in contributing to climate changes adaptation and mitigation. Jatropa as example is promising plant, which can used for oil production, and as well as green barrier against desertification in the arid zone. Many field experiments are promising.	More focus on new biofuels, ok. But need references.
17759	7	94				This is an extremely important chapter, lots of information in it; but the final end of it is somewhat abrupt	Noted, consideration under discussion.
4678	7	94	14	94	14	“---increased production of biofuels will have negative implications on biodiversity” ---. The word will should be changed to may, because biofuels can be made from existing NPP (e.g. wood and residues) by thermal distillation.	Accepted.
4679	7	94	20	94	22	This whole paragraph and in fact the whole section on sustainable development is very negative. How can residues be harvested at ‘unsustainable levels’?	Residues have their own function in ecosystems. I (Esteve) agree with the reviewer's note. I will bring a more positive tone by highlighting benefits in terms of employment, regional development, host-country R&D, etc.
17758	7	94	21			change the words "land is converted" to "land is irreversibly converted"	It is not clear that conversion is irreversible. Hence, this adjective should not be used.
3809	7	94	33	94	47	Only negative impacts of bioenergy are discussed. The text has to be fair.	Very general comment.
7749	7	94	45	95	2	I strongly recommend that Brazilian papers on this issue are investigated. Palm oil in Brazil is not produced by large farmers. This is an important production in isolated communities in the Amazon. It has absolutely nothing to do with soybean production. Please, access the issue adequately.	We cannot discuss individual countries. We should have a balanced statement, citing a review paper.
5741	7	94	9	94	99	The recently completed Bioenergy and Food Security Criteria and Indicators (BEFSCI) project of the FAO has identified a set of good practices and policy options on sustainable bioenergy production that foster rural development and food security (including agro-forestry practices). ( <a href="http://www.fao.org/docrep/015/i2596e/i2596e00.pdf">http://www.fao.org/docrep/015/i2596e/i2596e00.pdf</a> but also <a href="http://www.fao.org/bioenergy/foodsecurity/befsci/en/">http://www.fao.org/bioenergy/foodsecurity/befsci/en/</a> in general)	Read this.
15357	7	94	12			Reference to definitions of food security and food security policies would add more value to this section as this plays a significant role in policy decisions to promote large scale biofuel production	Noted, consideration under discussion.
3810	7	95	11	95	11	Replace "desposition" by "participation".	Participation seems to be inappropriate here.

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4681	7	95	17	95	18	Again the word 'Traditional' is used. Does this include wood used for heating purposes by households, the services sector and with district heating? Why make the distinction?	See suggestion. Agree with dropping charcoal (the charcoal there was the very low efficiency one)
3811	7	95	25	95	25	Define what "advanced biofuels" means. For the USA, first generation ethanol from sugar cane produced in Brazil is known as "advanced ethanol".	Agreed that "advanced" needs definition or replacement with more specific terms.
3812	7	95	26	95	26	Check figures regarding growth between 2008 and 2012!!!	Noted, consideration under discussion.
7750	7	95	3	95	7	It is also not easy to establish a pattern that needs to be reproduced for biodiesel production for all kinds of oil seeds in all parts of the world and this needs to be addressed. Implementing certification patterns from one country in another one may be extremely dangerous and inadequate.	Reflect this. Esteve is willing to review the most up-to-date literature on the pros and cons of certification schemes, particularly the experience of soy and oil palm in a range of developing countries.
4682	7	95	36	95	37	"In the absence of growth-enhancing measures, increased biomass extraction reduces forest C stocks". I have tried to demonstrate that the existing accessible NPP, especially from wood is more than the forecasted demand for biomass energy. Therefore, I strongly disagree with the statement that 'increased biomass extraction reduces forest C stock. This only occurs when there is a change of land use. In such circumstances, it is better to salvage this stock, rather than burn it in situ.	Noted, consideration under discussion.
3813	7	95	41	95	42	Remove sentence since it is a repetition from above.	The sentence above (the first mentioning) is deleted.
3814	7	95	42	95	44	Check if the statement is really applicable to degraded lands. Recovery of degraded land is considered as a remarkable achievement, which had not be successful when providing food and feed at competitive cost.	Need to present both sides.
4680	7	95	9	95	10	"Altogether, by 2050 global primary bioenergy could contribute 20 to 250 EJ --- and by 2100, 10 to 330 EJ ---". This does not fit with the facts. At present, bioenergy consumption is an estimated 50 EJ (see Table 2 above). Thus, you are predicting that with a 'minimum' bioenergy forecast its consumption could fall to 20 EJ by 2050 and further decline to 10 EJ by 2100. This is extraordinary! What will take its place? Electricity from hydro, solar and wind? What will happen to the NPP? If it is not used, there is a good chance that 'wild fires' will consume some of it and this could seriously affect the habitat for animals, especially humans. On the other hand, the 'maximum' bioenergy forecasts predict that consumption could rise to 250 EJ by 2050 and to 330 EJ by 2100. But these numbers are still less than the accessible NPP 500-515 EJ (Table 2 above). And this does not take into account new investment in biomass planting. The minimum figures do not agree with the figures in the next paragraph (l 16-18). I think the forecasts are neglecting existing net primary production, assuming that future biomass production will come from new biomass production initiatives. I think this section should be amended to take into consideration existing biomass growth (NPP).	Noted, consideration under discussion.
3815	7	96	16	96	18	There are activities being carried out by a large actor in the sugar cane sector in Brazil - ETH Bioenergia involving the use of large degraded areas for sugar cane crop. Please, check the web through the company name plus sugar plus Brazil.	Unfortunately, we don't have the space to discuss specific activities (nor should we cite company websites)

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3816	7	96	19	96	21	See EPA, 2010 where it is shown that sugar cane plantation in Brazil, responsible for 1/3 of global ethanol production has excellent energy balance and saves more than 60% of the GHGs emissions due fossil fuel replacement. Thus, your statement is not supported by credible publications. EPA, 2010 - EPA (Environmental Protection Agency). Renewable Fuel Standard Program (RFS2), Regulatory Impact Analysis. Assessment and Standards Division, Office of Transportation and Air Quality. EPA-420-R-10-006, February (2010).	The replacement effect is debatable. As pointed out, this is a more "sceptical" scenario. The EPA analysis is in a projected 2022 world that assume no more burning of sugarcane trash and other arguable assumptions about fossil fuel displacement, and yield growth, and depends in part on amortizing ILUC over 30 years. What EPA has shown is the result of one idiosyncratic, future scenario.
4683	7	96	21	96	22	"For example, unfavorable land-use changes associated with bioenergy development can lead to very high GHG emissions (possibly exceeding 500 Gt [C or CO2?]) Melillo et al 2009 ----". Of course, if tropical high forests are cut down to grow soy bean or sugar cane for biofuels about 100 to 150 t of carbon will be lost per ha. Assuming that the GHG emissions are Gt C, this means that between 3,333 and 5,000 million ha of tropical high forest will be felled and converted to such crops. The land area of Brazil is 851.2 million ha. Therefore, a country 4 to 6 times the size of Brazil will be converted to biofuel crops if the C emissions are up to 500 Gt C! IF 500 Gt refers to CO2, then the area required would range from 910 to 1,364 million ha, still in excess of the land area of Brazil! It is surprising that Melillo was one of the authors of the above prediction, seeing he estimated that the NPP of land based plants is an estimated 53.2 Gt C, of which 43% is in the tropics (Openshaw, K. 2011b). Incidentally, a book on photosynthesis by Hall and Rao agree with Melillo estimate for NPP. (Hall D.O. & Rao K.K. 1994). Photosynthesis, fifth edition, Cambridge University Press. ISBN 0-521-43622-2). In my opinion, this annex does not take in to consideration existing net primary production. It assumes that existing biomass production is hardly sustainable and that increased bioenergy demand will have to come from additional investment. I have tried to demonstrate that there is a considerable surplus of existing NPP and with simple training, improved management and allowing local people access and control over forests and other lands, much more annual biomass growth could be used sustainable. This should assist in poverty alleviation.	Noted, consideration under discussion.
3817	7	96	26	96	28	Remove sentence since it is a repetition.	Noted, consideration under discussion.
6236	7	97		135		the references are almost exclusively from academic sources with no significant inputs from industry, governments or think-tanks. Publications from the Energy sector MUST be included.	Peer-reviewed literature only in IPCC reports. Gray literature only when nothing else is available.