WMO

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

UNEP

IPCC Fourth Assessment Report

Expert/Government Review of the Second-Order Draft

Chapter 4

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-1	A	0	0	0	0	General: Observation that "electrical equipment" resp. "high voltage gas insulated substations" is dealt with in Chapter 7-Industry (e.g. 7.4.8) and Chapter 4--Energy Supply in parallel. In both cases same applications for transmission, distribution of electricity are meant. Other hand it is noted that different terms are used. Enough background on this subject is available inside current IPCC documentation: New IPCC 2006 Guidelines for National GHG Inventories-Volume 3-IPPU(Industrial Processes and Product Use)-Chapter 8--Other Product manufacture and Use together with Volume 3 Glossary for IPPU would give not only background but also all necessary terms and definitions. To secure consistency on terms inside IPCC documents and Chapters of the 4th assessment report I'd like to suggest the following: 1.Concentrate all relevant information in one of the chapters--preferably Ch.7 and make reference to that in Ch.4.--2.Introduce above IPCC 2006 guidelines source at appropiate place in the text and list it under References (Friedrich Plöger, Siemens AG)	Accept – checck consistency
4-2	A	0	0	0	0	General: Observation that "electrical equipment" resp. "high voltage gas insulated substations" is dealt with in Chapter 7-Industry (e.g. 7.4.8) and Chapter 4--Energy Supply in parallel. In both cases same applications for transmission, distribution of electricity are meant. Other hand it is noted that different terms are used. Enough background on this subject is available inside current IPCC documentation: New IPCC 2006 Guidelines for National GHG Inventories-Volume 3-IPPU(Industrial Processes and Product Use)-Chapter 8--Other Product manufacture and Use together with Volume 3 Glossary for IPPU would give not only background but also all necessary terms and definitions. To secure consistency on terms inside IPCC documents and Chapters of the 4th assessment report I'd like to suggest the following: 1.Concentrate all relevant information in one of the chapters--preferably Ch.7 and make reference to that in Ch.4.--2.Introduce above IPCC 2006 guidelines source at appropiate place in the text and list it under References (Friedrich Plöger, Siemens AG)	duplicate
4-1	A	0	0	0	0	Isn't it good to tell something about the rising prices due to higher costs for material and energy? Instead of lower prices due to R&D and technological learning, the	noted

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						prices went up during 2005. This will be a temporarily effect and is probably valid for other technologies as well. (Theo J. de Lange, Energy research Centre of the Netherlands ECN)	
4-2	A	0	0	0	0	The consideration to countries which do not have suficient geological storage capacity should be made. I consider the following sentance based on SRCCS should be added in Chapter 4; "It is likely that the technical potential for geological storage is sufficient to cover the high end of the economic potential range, but for specific regions, this may not be true." (Yukio Yanagisawa, The University of Tokyo)	accept
4-3	A	0	0	0	0	General comments on chapter 4: Throughout the report, there's a strong bias in favour of nuclear energy and CCS, based on estimated production costs. Despite the fact that some of the renewable energy generation costs for the future are set higher than their current production costs (on good locations), the chapter lacks any independent proof of future CCS and nuclear energy generation costs.In fact, current renewable energy technologies are compared to proposed CCS and nuclear technology that do not even exist (e.g. "Generation III+" and "Generation IV" reactor). Some of the CCS technologies, and their believed future electricity generation costs, don't even exist as pilot projects. The nuclear reactors of "Generation III+" and even "Generation IV" are slogans of the nuclear industry rather than serious technology concepts. None of these concepts has been built or tested and therefore reliable cost analyses do not and cannot exist. In comparison, renewable energy technologies already represented a US$38 billion market in 2005: therefore renewable technology has already proved to be reliable.Based on this false cost analysis, the estimated growth rates for renewables are set far too low (even below the renewable energy growth rates of the last decade). The lack of bigger market volumes results (via the learning curve method) in high production costs. This false future cost prognosis for renewables is used to justify a wrong market volume estimation. At the end of the chapter the results of the calculation, which have been made using inaccurate assumptions, is again used to justify the wrong estimated outcome. In order to get a	Noted – but space limited and no references

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						clearer picture, I recommend doing a cost analysis based on the current available technology, plus an outlook for the next 10 to 15 years. The cost analysis should only accept proven technologies, which are already commercially available. Scenarios: All future energy scenarios are sourced from either IEA or WEC. No other sources have been included. I recommend including further alternative energy scenarios in order to get a more complete picture and a less narrow perspective: Chapter 4.2.3 Regional development trends must include further alternative energy scenarios. Chapter 4 has 362 references – almost 10% (33) are from IEA. Graphs: Almost all the graphs are of a very low quality; some (e.g. page 12) can hardly be read and therefore do not provide any further useful information. Either the graphs should be of a far higher quality or they should be removed. (Sven Teske, Greenpeace International)	
4-4	A	0	0	0	0	Chapter Four on Energy Supply is an impressive and comprehensive review of the future of energy supply. It talks appropriately about the evolution away from fossil fuel based energy systems, but it would be a far more powerful analysis if the period in question (until 2040+) was divided into two parts (say the next 15 years and then a subsequent 25 years?). The reason for this is the pricing of fossil fuels. The implicit assumption of Chapter Four seems to be that fossil fuels (especially conventional oil) are running out at a pace that will keep their prices high and encourage alternative fuels or nonconventional energies. This assumption seems evident in the text in spite of the fact that the draft report does not fully embrace the peak oil argument. Certainly coal will remain very price competitive with any other energy. In the next 10-15 years, moreover, the supply and demand fundamentals for oil will dictate lower prices. It is only the geopolitical threats to oil flow that could keep oil prices as higher as recent levels. In the next one to two decades, fossil fuel prices may not be as strong as they have been since 2003. In the period after that, this reviewer would agree that the resource scarcity arguments begin to be more compelling. In the meantime, however, if fossil fuel (especially oil) prices come down, policymakers will have a harder time pursuing policies that reduce fossil fuel use and thus mitigate CO2 emissions. If this chapter is designed to inform	Noted – but space limited and no references

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						policymakers of the energy situation, it should sound the warning that, in the short run (up to 15 years), oil prices in particular are not on a permanent upward trajectory and may temper in a manner that will work against the development of policies to move away from fossil fuels. I understand that this chapter is not intended to forecast oil prices, but the explanation that current oil prices are more a function of cyclical developments than a permanent scarcity premium would be a more realistic characterization of the current situation. (Sarah Emerson, Energy Security Analysis, Inc)	
4-5	A	0	0	0	0	Land use availability for biomass and food in developing nations. Whether biomass should be transported to other nations or will be used to in-country emissions reductions if it is harvested sustainablly. (NOIM UDDIN, Macquarie University, Sydney)	Noted – but space limited and no references
4-6	A	0	0	0	0	Biomass is not CO2 neutral, large BIGCC with CO2 capture and storage may lead to CO2 negative emiting energy systems. Interesting to report how CHPBIGCC would compete with CHPNGCC with CO2 capture and storage in future where there is a demand of heating (ref. Uddin and Barretto in press) (NOIM UDDIN, Macquarie University, Sydney)	Noted – but space limited and no references
4-7	A	0	0	0	0	This is a very different draft for the FOD and as such may generate complaints from reviewers who sent in comments and suggestions but which are not at all covered in this draft. However, I think this is a much improved version from the FOD. However, the executive summary for this chapter also needs to be rewritten and bring forward the main messages from the chapter. Better balance is also needed between the technologies is needed, eg CCS, renewables, nuclear power, etc. I did also notice that the references needed to be checked, I began to note down some of the missing references but did not have time to do the entire list. The coal section should be expanded or at a minimum perhaps consider including a reference as their is for solar and other sections referring to IEA implementing agreements where more information on technologies can be included. Perhaps a box with the relevant IEA Implementing Agreements and their websites is an option for readers to get up to date information on technologies or to liaise with chapter 1 to cover it	accept

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						in a box. Lastly, bioenergy section is quite long and should be shortened as well as also discussing the barriers to research, see IPCC Tokyo Expert Meeting report and also IPCC Capetown report earlier this year (John Kessels, Energy Research Centre of the Netherlands)	
4-8	A	0	0	0	0	GENERAL COMMENT ON REFERENCES. There is number of references that seem arbitrary choices, others are in the reference list but not used in the text . In some cases, they appear to support self-explanatory statements that do not need any reference. In other cases, the references are about too specific situations, events, or technology niches, that I do not think fit in a general assessemnet of the nature of an IPCC AR. I have tryed to point out some. I did the same in the FOD but some authors have not taken notice in the SOD and chosen to mantain even some references that I judge impossible to defend. I ask the REVIEW EDITORS to follow this, and check that the specific suggestions to reduce the number of references and unnecessary text are considered, or properly rebooted by the authors in the next version. (JUAN CARLOS ABANADES, INCAR-CSIC)	Accept – update references
4-9	A	0	0	0	0	Many of the references have been superceded by newer data - particularly the BP Statistical Review - the 2006 edition (with 2005 data) should be used to ensure a more accurate picture of current energy supply/demand issues is provided. The latest IEA World Energy Outlook will be published in November 2006 and I would make a plea for this data to be used if possible, otherwise the value of the IPCC report may be significantly diminished (,)	accept
4-10	A	0	0	0	0	The whole chapter seems to be very unbalanced: CCS and Nuclear energy were systematically preferred, whereas the perspectives of renewables were underestimated. This does not reflect the state of empiric, technical and scientific knowledge. (,)	Noted – but space limited and no references
4-11	A	0	0	0	0	Please see my Commentary titled "Addressing Potential Abrupt Climate Change" which does not fit into this Excel spreadsheet box. I have accordingly asked Dave	Noted – see ch8

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						Rutu to circulate it to lead authors. It draws attention to a body of peer reviewed and gray literature which appears to have been overlooked in the SOD, although it was brought to attention previously in my comments on the FOD. The main point is that the rest of the literature mostly treats atmospheric CO2 as a flow pollution problem, to be addressed through a reduction in emissions. However CO2 is not a noxious gas, and therefore atmospheric CO2 is an excess stock problem with several possible answers. It is technologically much easier to extract CO2 from the atmosphere by land use improvements that increase biotic absorption and yield biomass fuels (de-fossilization) than it is do without any fuel other than hydrogen (decarbonisation). In this Chapter I suggest the matter can be dealt with by a footnote on page 16. My detailed comments are based mainly on a reading of the Execcutive Summary and Sections 4.3.3.3, 4.3.6, 4.5.1.1 and 4.5.4.4 (Peter Read, Massey University)	
4-12	A	0	0	0	0	Please see my Commentary titled "Addressing Potential Abrupt Climate Change" which does not fit into this Excel spreadsheet box. I have accordingly asked Dave Rutu to circulate it to lead authors. It draws attention to a body of peer reviewed and gray literature which appears to have been overlooked in the SOD, although it was brought to attention previously in my comments on the FOD. The main point is that the rest of the literature mostly treats atmospheric CO2 as a flow pollution problem, to be addressed through a reduction in emissions. However CO2 is not a noxious gas, and therefore atmospheric CO2 is an excess stock problem with several possible answers. It is technologically much easier to extract CO2 from the atmosphere by land use improvements that increase biotic absorption and yield biomass fuels (de-fossilization) than it is do without any fuel other than hydrogen (decarbonisation). In this Chapter I suggest the matter can be dealt with by a footnote on page 16. My detailed comments are based mainly on a reading of the Execcutive Summary and Sections 4.3.3.3, 4.3.6, 4.5.1.1 and 4.5.4.4 (Peter Read, Massey University)	duplicate
4-13	A	0	0	0	0	There is a general tendency in the chapter to focus on available resources and ignore the fact that constraints will be felt long before we run out of resources.	Noted – but space limited and no references

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						Furthermore, it is increasingly evident that remaining resources, as defined by the US Geological Survey and the IEA, are hevily over estimated. Over the last more than 100 years, according to the IEA, 1.5 trillion barrels of oil equivalent (boe) of oil and gas have been produced. A further 1.5 trillion boe will be needed to meet global demand up to 2030. But proven oil and gas reserves are just 2.2 trillion boe, So will that leave us with 0.7 trillion boe in oil and gas reserves in 25 years' time? No, says the IEA, because reserves will increase as we are able to extract oil and gas from more difficult areas such as the Arctic regions and "deep and ultra-deep water". Whether the IEA is right or not, the main question for importers of fuel – and that is most countries in the world - is not so much what fuel resources exist as when the steady depletion of finite resources will become too much of a burden on our economies? Some say it already has. Others, such as Goldman Sachs believe that we have only seen the beginning of fuel price increases. As these words are being written a barrel of oil costs $72, and shows no sign of coming down. In terms of oil production, according to a new report investigating remaining resources "Plugging the gap" [see: http://www.gwec.net/index.php?id=30&no_cache=1&tx_ttnews[tt_news]=38&tx_ttnews[backPid]=4&cHash=dbc03a0183], we are already consuming more than three times as much as we discover, and have used around half of the world's regular oil resources. Natural gas production will peak in around 2030 and we have already started to use more gas than we find. Prices are starting to reflect that peak. And prices are what matters. In terms of oil production, according to the report, we are already consuming more than three times as much as we discover, and have used around half of the world's regular oil resources. Natural gas production will peak in around 2030 and we have already started to use more gas than we find. Prices are starting to reflect that peak. And prices are what matters. For now, coal is plentiful, but by 2030 the world will have consumed 20% of its	

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						current reserves, rising to 40% by 2050. By the end of this century coal will also be exhausted unless we change direction. Current uranium reserves for nuclear power will also be exhausted in 60 years. The main conclusion to draw from all this is: this century, the world will run out of those finite fuels on which our economies are based. But the economic effects will be felt many decades before that happens. The gulf between fuel demand and supply availability is widening, and alternatives to conventional sources will have to be deployed if we are to avoid a global economic and environmental collapse. (Christian Kjaer, European Wind Energy Association)	
4-14	A	0	0	0	0	In many places in the chapter, the Second Order draft refers to the undocumented but often quoted myth that wind energy faces dramatic barriers beyond penetration levels above 20%. We strongly recommend that the authors investigate the reports and scientific papers on this complex issue, if it wants to include it. Below are references to the IEA, the UK Energy Research Centre and EWEA which all contains references to numerous studies on the issue. The term "intermittency" is misleading in relation to wind power. Wind is variable but predictable and a system never experiences that all wind farms trip of the systems instantly. It happens gradually. When a large thermal or nuclear power plant trips off the system, on the other hand, it happens instantly, so this may be termed "intermittent" but wind power is variable. Variability of electricity demand and supply is as old as electricity itself. It is not a new challenge brought about by wind power. If the IPCC wants a general debate about the task of transmission system operators of continuously matching supply and demand, the debate must be broaden out to other technologies. Balancing, variability and back-up power is not an issue specifically related to wind power as the current dtaft suggests. To give an example, more than half of Swedens nuclear power stations were taken off the grid for safety reasons in the summer of 2006. Ofcourse it required back-up to make sure the electricity kept flowing to the Swedish consumers. If the Swedish power system can absorb thousands of MW of nuclear power that is taken off the grid instantly, ofscourse it	Noted – incorporate in wind section

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						can absorb the variability of wind energy. The reality is that most electricity systems in the world can accommodate wind energy up to 20% without making any significant changes to current infrastructure. Beyond 20%, depending on the individual system, it may be necessary to make adjustments, but "accurate forecasting", "demand side response measures" and "storing" are not needed, as documented in numerous studies, to increase wind power penetration beyond 20%. The International Energy Agency concluded in its report "Variability of wind power an other renewables that "the experience with wind power showed that integration was more an economic and political issue than a technical issue" and gave as an example of the economics that the additional system cost for 20% wind and biomass scenario in UK was €0.44/MWh, or less than 1% of generation cost of power. Furthermore, any cost estimation of balancing and reserve capacity must include a comparison to other technologies. A recent report from the UK Energy Research Centre comes to similar conclusions as the IEA - see http://www.ukerc.ac.uk/content/view/11/86/ - and compares the cost of wind power variability to that of gas. It says: "If wind power were to supply 20% of Britain's electricity, intermittency costs would be 0.5 - 0.8p per kilowatt an hour (p/kWh) of wind output. This would be added to wind generating costs of 3 - 5p p/kWh. By comparison, costs of gas fired power stations are around 3p p/kWh.The impact on electricity consumers would be around 0.1p p/kWh. Domestic electricity tariffs are typically 10 - 16p p/kWh. Intermittency therefore would account for around 1% of electricity costs". If the IPCC report wants to make a big issue out of the complex subject of variability, it should get a better understanding of the facts. I warmly recommend to read the above report from IEA as wells as EWEA's publication "Large scale integration of wind energy in the European power supply: analysis, issues and recommendations (December 2005)" – see http://www.ewea.org/index.php?id=178 (Christian Kjaer, European Wind Energy Association)	
4-15	A	0	0	0	0	This chapter is excellent, considerably improvement over the previous draft. (Chris Mottershead, BP)	Accept – with thanks

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4-16	A	0	0	0	0	The mitigation potential calculation needs to be checked. There is an issue with the correct representation of the baselines in the calculation. (Expert Review Meeting Paris, IPCC)	accept
4-17	A	0	0	0	0	The chapter should describe the state and impacts of high oil prices. More coal and non conventional fuel pose extra challenges, but high oil prices may also create opportunities for other technologies and policy instruments. (Expert Review Meeting Paris, IPCC)	accept
4-18	A	0	0	0	0	recommended to pay more attention to the energy efficiency of the supply sector itself. (Expert Review Meeting Paris, IPCC)	accept
4-19	A	0	0	0	0	It was recommended to use the same format for all technology paragraphs and to show potentials and the barriers for each in commensurate units. (Expert Review Meeting Paris, IPCC)	accept
4-20	A	0	0	0	0	As it is a key issue for energy Ministers chapter 4 should pay some attention to the links with energy security. (Expert Review Meeting Paris, IPCC)	accept
4-21	A	0	0	0	0	This chapter deals with Energy Supply; on the other hand, the use of traditional energies is not subject to an in-depth development whereas it is mentioned in chapter 6 : Residential/ commercial page 13 line 30 « Worldwide, about three billion people use solid fuels- biomass and, mainly in China, coal-in household stoves to meet their cooking, water heating , and space heating needs ». It is mentioned that section 4.3.3.3 “concentrates on the conversion technologies of biomass resources to provide bio-energy in the form of heat, electricity and transport fuels to the energy market. Whereas in most of the developing countries particularly those in sub Saharan Africa, some of the traditional energy (wood and charcoal) represents more than 70 % in the overall energy balance. For example, in the counties of the Economic Community Of West African States (ECOWAS) which brings together 15 countries of West Africa, biomass represents 88 % of the final energy consumption in 2003, (source Ecowas 2006). Along with this, are the consequences that emanate from it in terms of negative impacts on health and in the	Noted – check reference

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						potential degradation of the environment. So it will be an opportunity to develop more on traditional energies and to show best practices in the effective promotion and management strategies of the sustainable supply of the resource. For example, Senegal has set up forestry code by decree dating back to 1998, and by this decree the production of the biomass is not only fixed on quotas but its exploitation is open to only two localities of the country to avoid the loss of the wood potential which can become carbon sink. In the same way, the good experiences in the techniques of carbonization which makes it possible to save a great quantity of wood should be approached for a durable and rational management and exploitation of the forest resources. The supply of energy should not only concern modern energy. Traditional energies which meet the energy needs of most of the people in developing countries especially those in the rural areas should not be excluded. (NOGOYE THIAM, ENDA- TM)	
4-22	A	0	0	0	0	It is essential that the high oil price scenarios as will be considered in the 2006 IEA World Energy Outlook is considered within this chapter. (Nick Campbell, ARKEMA SA)	accept
4-23	A	0	0	0	0	It is essential that the high oil price scenarios as will be considered in the 2006 IEA World Energy Outlook is considered within this chapter. (Jean-Yves CANEILL, EDF)	accept
4-24	A	0	0	0	0	Overall, this is a nicely balance discussion, with appropriately spaced caveats and summaries. However, I do notice some redundancies in the first few sections. With meticulous editing and re-organization of the material – especially moving all of the background introductory statistics to section 4.1 - it should be possible to trim the length a little. (Danny Harvey, University of Toronto)	noted
4-25	A	0	0	0	0	There is quite some imbalance between different sections of the report - biomass/bioenergy have a whopping 9/10 pages dedicated to the subject, while other energy sources get an average of 2. This is disproportionate and must offer a large opportunity to shorten the report. (Christine Copley, World Coal Institute)	Noted – but space limited and no references

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4-26	A	0	0	0	0	Overall, the chapter would benefit from a clear, upfront statement of scope - i.e. that this is a literature review, not a statement of policy; and clarify which time period is being considered. If issues ONLY since TAR are being considered in the report, this should be very clearly stated (and sections checked that they comply with this) (Christine Copley, World Coal Institute)	Accept – will do
4-27	A	0	0	0	0	Cost and data comparisons will inevitably be made across different sections of the report. As these come from a number of different models, assumptions and scope will be different. Equally, many of the cost data will come from assumptions of a much lower oil price than is currently the case. A very clear statement or caveat regarding this would be extremely useful. (Christine Copley, World Coal Institute)	Noted – 4.4 being rewritten
4-28	A	0	0	0	0	Many of the cited references are not in the reference list making it impossible to check original sources. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accept – will update
4-29	A	0	0	0	0	Chapter 3 gives rather a lot of attention to biomass with Carbon capture and storage. Biomass is rarely used today in applications of the sort of size that would be compatible with CCS and achieving a growth in such applications presents a certain challenge. Detailed techno-economic analyses concerning large-scale biomass conversion (including analysing the biomass supply) with CCS are uncommon, but results from existing studies should be reported here, especially new publications since the SRCCS deadline. Note that biomass with CCS is pointed out in the SRCCS as an area with few published studies. Recent publications that analyse (in more or less detail) biomass with CCS in the electricity and fuel supply sectors include: Techno- economic issues: - Azar Ch, Lindgren K, Larson ED, Möllersten K, (2006). Carbon capture and storage from fossil fuels and biomass – Costs and potential role in stabilising the atmosphere. Climatic Change 74 (1-3): 47–79. - Larson ED, Jin H, Celik FE. Gasification-based fuels and electricity production	Noted – but space limited

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						from biomass, without and with carbon capture and storage. Princeton, NJ: PEI, Princeton Univ; 2005, 77 pp. - Williams R et al. Synthetic fuels in a world with high oil and carbon prices. Proceedings 8th Greenhouse Gas Control Technologies Conference, Trondheim, 2006. - Larson E D et al. Fuels and electricity from biomass with CO2 capture and storage. Proceedings 8th Greenhouse Gas Control Technologies Conference, Trondheim, 2006. - James S. Rhodes and David W. Keith 2005: Engineering-economic analysis of biomass IGCC with carbon capture and storage. Biomass & Bioenergy, 29: 440-450. National inventories and accounting: - Grönkvist S, Möllersten K, Pingoud K. Equal opportunity for biomass in greenhouse gas accounting of CO2 capture and storage: A step towards more cost-effective climate change mitigation regimes. Mitigation and adaptation strategies for global change. Available online March 2006. (Kenneth Möllersten, Swedish Energy Agency)	
4-30	A	0	0	0	0	A comment on terminology: Carbon storage can occur either through "engineered" storage in for example geological formations and ocean water, or through the biological uptake in growing biomass and soils. In this chapter, it is sometimes unclear which of these two alternatives are actually referred to when the terms "storage" and "sequestration", respectively, are used. One way to improve the text would be to consistently use either "storage" or "sequestration". This would not help to differentiate but it would be less confusing compared to the present text. Another (and better) option would be to use "storage" for engineered storage and "sequestration" for storage through biological uptake. The latter option would ease the differentiation between the two storage strategies. In any case consistency is important within the chapter, but also between this chapter and the other chapters of the report.	Noted – need consistency

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						(Kenneth Möllersten, Swedish Energy Agency)	
4-31	A	0	0	0	0	This comments concern only nuclear power. Chapter 4 depicts an unrealistic image of the possibilities of nuclear power in the world energy supply and of its potential contribution to mitigation of anthropogenic climate change. Often proven technology and paper concepts are presented together without distinction. Sometimes a theoretical principle is presented as a sound option only needing money to develop into a mature technical system, for example transmutation of long-lived radioactive waste into short-lived. Large uncertainties - environmentally and economically - caused by unproven technology in the back end of the nuclear chain, e.g. dismantling and final waste disposal, pose a large risk for and an unavoidable but heavy burden on future generations. These uncertainties and risks are ignored by the authors. In my view the authors of the nuclear section of Chapter 4 fail in their duty to give policy makers the solid information they need to conceive a policy intended to give all groups and interests in our society their due. The whole section on nuclear power in this Chapter 4 suggests a scientifically sloppy approach. (Jan Willem Storm van Leeuwen, Ceedata Consultants)	Noted – but space limited and no references. Ch deals specifically with new technologies
4-32	A	0	0	0	0	Table 4,2,1 More than 3 significant figures are excessive, given the uncertainty and differences between the different assessments (Stefano Caserini, Politecnico di Milano)	accept
4-33	A	0	0	0	0	An important omission in this chapter is the necessary distinction between the main forms of useful energy, ie heat, work and light. Although information is scarce, heat seem to represent about half of our total energy needs (see Philibert 2006: Philibert, Cédric, 2006, Barriers to the diffusion of solar thermal technologies, OECD and IEA Information Paper, Paris (forthcoming, current draft appened). Thisdistinction is absolutely necessary to apprehend the real potential of solar thermal technologies, as well as combined heat and power and geothermal potentials. (Cédric PHILIBERT, International Energy Agency)	Accept – CHP section being rewritten
4-34	A	0	0	0	0	General comment. Found Chapter 4 (energy supply) easier to read than Chapter 7	noted

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						(Industry) because the authors of the former don't bother to have tC conversions everytime they use tC numbers. It makes for better reading flow without tC conversions. Maybe a conversion table at the back would be better. (Catherine Beard, Greenhouse Policy Coalition)	
4-35	A	0	0	0	0	There is data available for the mitigation of CH4 from natural gas and coal mining as well as information on SF6 from electricity distribution (see USEPA 2006). I don't see any of this data in the energy information in the SPM, TSU, or Chapter 11 under Energy Supply. All three are marked as CO2 only. (Katherine Casey Delhotal, Research Trinagle Institute)	accept
4-36	A	0	0	0	0	General missing: energy efficiency and energy storage (Gabriela Von Goerne, Greenpeace)	accept
4-37	A	0	0	0	0	General comment: It would be helpful if reserves (proven), and resources would be discussed in all the same way for coal, gas and oil, including how long they both will last under given assumptions. (Gabriela Von Goerne, Greenpeace)	accept
4-38	A	0	0	0	0	General comment: Insert sub-chapters on „risks and environmental impacts“ to all energies discussed (e.g like done with uranium sub-chapter 4.3.2.2 and discussed under 4.3.3.4 geothermal on page 51, line 1-4) (Gabriela Von Goerne, Greenpeace)	Noted – but space limited
4-39	A	0	0	0	0	While discussing CCS technology under section 4.4.3.4, it is suggested to include Biomass CCS, which results in negative GHG emissions. These are also covered under IPCC SRCCS, and IPCC 2006 Inventory Guidelines. (Government of India)	Noted – for CCS section
4-40	A	0	0	0	0	Total coal reserves are given as 12,845 Gt/ CO2 equivalent and this works out to 140,000 EJ. The current consumption is given as 100 EJ and on this the coal reserves (not even prospects) will last for 1400 years! May be this figure also needs to be verified. (Government of India)	Noted – but where is the reference?
4-41	A	0	0	0	0	There are certain discrepancies in the report. For example in para 5, 4.4.3 on CCS	Noted – CCS section 4.3.6 being rewritten

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						technologies, the current emissions are given as 25 Gt CO2 while in 4.3.3.1 this figure is 9.175 Gt of CO2. Similarly the energy consumption currently on coal alone is 100 EJ (coal is indicated as 24% of total energy which means total energy consumption today is 426 Ej), while in 4.4.3 paragraph 20 says the primary energy by 2030 is 255.9 EJ / yr which appears much less. (Government of India)	

x

Comments on section 4.2

4-374	A	11	13	11	21	There is a critically important conclusion in this paragraph: "Addressing environmental impacts, including climate change, usually depends on regulatory laws and tax incentives rather than market mechanisms." Notwithstanding the real value of the cap and trade programs and other market-based mechanisms, it is important to remember that it will take regulation not markets to bring about energy decisionmaking that is climate friendly. The idea that fossil fuels will price themselves at a level that will make them increasingly marginal within the next 15-20 years is flawed.This idea may be more compelling in looking 30-40 years into the future. So, regulation is required to encourage a change in energy mix if progress is going to be made in the next three decades. This paragraph should be the heart of the message of chapter four to policymakers. (Sarah Emerson, Energy Security Analysis, Inc)	Noted The first part of para describes the presen status with conclusion that regulation is needed (last sentence) This aspect is discussed more elsewhere.
4-375	A	11	13	11	28	Please integrate this in a Table with cost important information; size, energy mix, sectoral distribution, related GHG emission. (Government of European Community / European Commission)	Rejected In principle suggestion is worthwhile, but not enough space is available
4-376	A	11	14	11	14	Change “no” to “minimum”. It is unreasonable to assume that there will ever be an energy supply system that has no environmental impact. Certainly none of the systems in use or under discussion today meet that criterion. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted
4-377	A	11	14	0	0	replace "no impact" with "minimise the impact" otherwise I guess hydro and wind farms would be considered undesireable.	Accepted

						(Michael Taylor, International Energy Agency)	
4-378	A	11	14	11	14	Change “no” to “minimum”. It is unreasonable to assume that there will ever be an energy supply system that has no environmental impact. Certainly none of the systems in use or under discussion today meet that criterion. U.S. Government (Government of U.S. Department of State)	Accepted
4-379	A	11	15	11	18	the sentence starting Recent Liberalization…who are you refering to in the literature (John Kessels, Energy Research Centre of the Netherlands)	Taken into account Replace “liberalization” with “Deregulation”. Broadly known development; thus no specific reference required
4-380	A	11	15	11	15	Delete "government" (The goals are not specific to governments) (Pat Finnegan, Grian)	Taken into account
4-381	A	11	15	11	0	“…government…only, not people/societies, general?” U.S. Government (Government of U.S. Department of State)	Taken into account
4-9	B	11	15	11	15	The authors should provide a citation for their claim that liberalization of the energy market has reduced long-term investment. (Government of Australia)	Rejected This is quite obvious observation. No citation needed
4-382	A	11	16	11	18	Some examples could be given : Absence of CSS, delays in building refineries or nuclear plants (Government of France)	Noted If possible within text space available
4-383	A	11	20	11	21	After this sentence there could be a reference to Section 13.2.1.1 (Kirsten Macey, Climate Action Network Europe)	Noted
4-384	A	11	23	11	24	This sentence as it now stands is not physically accurate change to "Primary energy sources (Figure 4.2.1) are: fossil fuels; uranium and other heavy nuclei that can fissioned; gravitational and rotational forces; geothermal heat arising mainly from the decay of radioactive minerals in the earth; and, the fusion reactions in the sun that produce the solar flux." (David Jackson, McMaster University)	Taken into account The suggestion will be adopted in modified and shortened form (e.g. uranium and thorium)
4-385	A	11	23	11	23	delete extra comma (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-386	A	11	23	11	28	The 2nd paragraph of Section 4.2 and the accompanying figure (see nect comment) should be eliminated or revised greatly.Beginning on line 23, the text states that primary energy sources come from fossil carbon fuels, geothermal heat and radioactive minerals, gravitational and rotational forces and the solar flux.The phrase “radioactive minerals” is a misnomer for nuclear fission and fusion. It	Taken into account; see also comments A384 & A388 “fossil fuels; uranium and thorium (other heavy nuclei that can fissioned); gravitational and rotational forces; geothermal heat arising

						seems to imply that the radioactivity of the mineral (say, uranium) is the energy source. The radioactivity of uranium and thorium are not used directly in fission energy. Fusion devices are currently run on deuterium (D-D) which is not a radioactive mineral. The phrase radioactive minerals should be deleted in preference to a more accurate description.The combination of geothermal energy and radioactive minerals into one primary energy category is not appropriate or helpful to the reader in understanding the energy sector. U.S. Government (Government of U.S. Department of State)	mainly from the decay of radioactive minerals in the earth; fusion materials such as deuterium, lithium, etc.; and, the solar flux."
4-10	B	11	24	11	24	If the authors mean hydropower, solar power, tidal power, etc they should list these rather than the confusing terms "gravitational and rotational forces; and the solar flux". (Government of Australia)	Taken into account More commonly known terms need to be preferred
4-387	A	11	24	13	0	The graph page 13 is an excellent presentation of the problem of energy cascades, in the example of lighting and its use for policy is quite relevant. But the legend page11 line 28 should mention that this is only an example. Suggestion : The conversion from primary energy to carriers and en-use is an essential driver of efficiency, shown in the case of lighting (Figure 4.2.2). (ANTOINE BONDUELLE, Université Lille II)	Taken into account
4-388	A	11	24	11	24	Change “radioactive minerals” to “fissionable, fertile, and fusionable elements”. U.S. Government (Government of U.S. Department of State)	Accepted The comment seems reasonable. see also comments A384 & A386
4-389	A	11	27	11	28	Distribution losses also contribute to the "cost of delivering" energy. (Joanna Lewis, Pew Center on Global Climate Change)	Accepted “delivering” is included after “conversion”.
4-390	A	12	0	12	0	Fig. 4.2.1 is complex and hard to read+K160??? (Government of France)	Noted The reality is complex. Fig. could be attempted to be simplified, in case it is possible
4-11	B	12	1	12	50	Figure 4.2.1 is impenetrable to non-engineers and requires further in-depth explanation. (Government of Australia)	Rejected This kind energy flow is popular in an energy related text.
4-391	A	12	1	12	0	This diagram is extremely difficult to read, can the font size me made large as well as the diagram is difficult to follow and I would suggest to make the diagram less busy by perhaps separting the smaller flows (geothermal, solar, wind,e tc) into a diagram below and having just the large energy flows showing otherwise its difficult to follow	Noted see above comment A390

						(John Kessels, Energy Research Centre of the Netherlands)	
4-392	A	12	1	12	11	Re figure 4.2.1: this figure is unintelligible without a great deal more explanation (Steve Sawyer, Greenpeace International)	Noted see above comment A390
4-393	A	12	1	0	0	Figure 4.2.1 is very complicated and hard to read. Please enlarge or simplify. (Steve Clemmer, Union of Concerned Scientists)	Noted see above comment A390
4-394	A	12	1	0	0	Figure 4.2.1 is very complicated and hard to read. Please enlarge or simplify. (Steve Clemmer, Union of Concerned Scientists)	Noted see above comment A390
4-395	A	12	1	0	0	Figure 4.2.1 This diagram shows an energy-from-uranium resource (225000 EJ) which is based on unfeasible concepts and not on technical reality, as explained in my comment on Figure 4.3.2 on page 32. I consider this a seriously misleading presentation. Moreover, the figure of 225000 EJ is not consistent with Figure 4.4.2 on page 75, nor with Table 4.3.1 on page 23, nor with Figure 4.3.2, nor with Table 4.4.2 on page 80. All mentioned Figures and Tables cite other numbers of the total energy-from-uranium resources. Which numbers are the right ones? The whole section on nuclear power in this Chapter 4 suggests a scientifically sloppy approach. (Jan Willem Storm van Leeuwen, Ceedata Consultants)	Taken into account Data and consistencies need to be checked.
4-396	A	12	1	12	1	The figure is very hard to read and complicated. Please make it readable and add more comments. (DELLERO Nicole, AREVA)	Noted see above comment A390
4-397	A	12	1	12	1	The figure is very hard to read and complicated. Please make it readable and add more comments. (DELLERO Nicole, AREVA)	Noted see above comment A390
4-398	A	12	1	0	0	Figure 4.2.1. Two points with regard to this Figure: 1) The display will need to be bigger; as it stands the type is too small to read. 2) What exactly the different colours represent is not clear. There appears to be a labelling system, however the read and pale grey lines appear to be missing labels. A graphic legend should accompany this figure to explain the meaning of the different coloured lines. (Government of Japan)	Noted see above comment A390
4-399	A	12	1	12	0	Figure 4.2.1. This shows world hydro and nuclear power primary energy to be equal, yet nuclear power is really about three times greater than hydro. U.S. Government (Government of U.S. Department of State)	Rejected Hydro and nuclear power provide roughly same amount of electricity, but the corresponding primary energy amounts differ by a factor of 3 owing to the adopted

							conversion practice by IEA (consistency with other sections needs to be checked)
4-400	A	12	1	12	0	Figure 4.2.1 should be deleted. There are 8 reasons for eliminating it. As presented, it does not assist the reader. Additionally, no meaningful review of the figure can be performed.Study of this chart under magnification indicates multiple errors on the yellow bars on the left-hand side of the page. As an overall statement, this chart avoids depicting the correct streams, flow, and endpoints associated with uranium enerfgy and instead substitutes a non-physical picture of uranium resources as being isotopically pure. The U-235 and U-238 isotopes do not exist in nature nor in any nuclear fission energy system as completely separated isotopic streams, such as is shown in Figure 4, 2.1. This depiction of uranium resources is similar to, and less sensible than, attributing the energy of fossil fuel sources to hydrogen combustion and carbon combustion – as if one is occurring without the other. U-235 and U-238 are always intermixed in uranium at some concentration. Uranium-235 requires one neutron absorption event to fission, whereas Uranium-238 requires 2 neutron absorption events to fission. Because only 2.3 to 2.7 neutrons are produced per fission event, nuclear reactors are designed to have enough U-235 (or Pu-239, which is produced by the first neutron absorbed by U-238) in the reactor to keep the fission chain reaction going. All uranium is a mixture of U-234, U235 and U-238 and all three isotopes are either fissioned or "bred then fissioned" to some extent, no matter which kind of reactor or fuel cycle is used.The chart represents the uranium energy resource in ways that are not physically or practically meaningful (as "U-235 once through fuel cycle" and as "U-235 Pits and U-238 fertility"). The existing LWR once-through fuel cycle currently produces a significant fraction of its nuclear energy (perhaps 10% or more) from U-238 (U-238-> Pu-239->fission). As nuclear fuel tends to higher fuel burn-ups in LWRs, the U-238 energy contribution has become relatively more important. Thus the chart inaccurately depicts the once-through fuel cycle as burning only the U-235 isotope. The phrase U-235 Pits refers to surplus highly enriched uranium (U-235=93%, U-238 =6%, U-234 =1%) that was enriched during the cold war and which now must be downblended for optimal sue in power reactors. These are grades of uranium (depleted, natural, low enriched, high enriched) and are not fundamentally different resources –they are analogous to the differences between high-grade crude and sour crude in the petroleum industry.Additionally, the uranium resource description in Figure 4.2.1 refers to Uranium-235 pits, which is a	Rejected Figure will be included. Wording and discussion of uranium isotopes could rephrased to more accurately refer to once-through thermal reactors and fast reactors with recycle (without solely referring to U-235 and/or U-238) The use of MOX-fuel in LWRs (e.g. in France) does not significantly add the resource utilization efficiency. The wording U-235 pits will be modified

						reference to a component of U.S. and Russian nuclear weapons. The term “pits” is nuclear weapons terminology and is jargon that is used by the nuclear weapons community, but is not widely understood by the energy community. It is not appropriate for this report. Additionally the CANDU reactor system used n Canada and South Korea, burns both U-238 and U-235 as natural uranium. It is a once through cycle and it burns all isotopes of uranium found in nature.Additionally, France recycles reactor-produced Pu and used a mixture of Pu and natural uranium as nuclear fuel in thermal spectrum light-water reactors. Figure 4.2.1 and the subsequent discussions seem to ignore the French nuclear fuel system. U.S. Government (Government of U.S. Department of State)	
4-401	A	12	3	12	0	Figure 4.2.1 This figure could use some simplification and explanation. Numbers cannot be read at scale presented--thus table is very difficult for readers to follow and understand taken out of context. Need to more fully explain the numbers and gradients shown and give units for all numbers. Also, "organic waste [is] included with biomass" and the biomass total is slightly less than the sum of nuclear and hydro energy...can we have a short discussion on these numbers so that we are coordinated between the sectoral chapters? (Jean Bogner, Landfills +, Inc)	Noted see above comment A390
4-402	A	12	4	12	4	Figure 4.2.1 what is the unit, very hard to read and main messages need to be highlighted at least, otherwise this graph is useless. (Government of European Community / European Commission)	Noted see above comment A390
4-403	A	12	0	0	0	Figure 4.2.1 This chart is too small. Yet the information it contains is absolutely crucial. It could usefully be rotated and printed in landscape orientation. Point size of text, and particularly, numerical figures in the graphic should also be enlarged. (Pat Finnegan, Grian)	Noted see above comment A390
4-404	A	12	0	13	0	Figure 4.2.1 and 4.2.2 are very interesting presentations. There is also a small editorial in figure 4.2.1 where the source is mentioned inside the notes. (Government of India)	Noted As for 4.2.2 all data source should be mentioned.
4-405	A	13	0	13	0	Fig. 4.2.2 : the three parts of the figure are totally cryptic. Which concrete data were used to draw it ? (Government of France)	Noted As for 4.2.2 all data source should be mentioned.
4-406	A	13	1	0	0	There is no discussion of Figure 4.2.2 other than in its caption. It doesn't add anything and should be removed. (David Jackson, McMaster University)	Taken into account Figure should be clarified. Alternatively - to save text space the possibility of replacing the

							Fig. with a few text lines only describing the main message, will be considered.
4-12	B	13	1	13	5	Figure 4.2.2 requires more explanation, in particular it would be helpful for the first row of numbers in each panel, to be explained. (Government of Australia)	Accepted The first row of numbers should be explained.
4-13	B	13	1	13	1	Fig. 4.2.2 unclear, please add caption (Government of Germany)	Noted Additional explanations (caption or text) can be considered
4-407	A	13	1	13	1	The figure is confusing. In the old text, there was an explanation of the figure but not here. (John Nyboer, Simon Fraser University)	Taken into account see also above comment A406
4-408	A	13	1	13	0	Figure 4.2.2. Need to add energy units to figure and label the processes for each set of arrows/bars. (Jean Bogner, Landfills +, Inc)	Noted Units should be mentioned. see also above comment A406
4-409	A	13	1	13	18	Re figure 4.2.2: this figure is unintelligible without a great deal more explanation and more identification of the significance of the figures in the table (Steve Sawyer, Greenpeace International)	Taken into account see also above comment A406
4-410	A	13	1	0	0	Figure 4.2.2 is hard to understand. Please clarify by adding headers or labels to each of the 3 main parts of the Figure. (Steve Clemmer, Union of Concerned Scientists)	Noted Figure should be corrected. see also above comment A406
4-411	A	13	1	0	0	Figure 4.2.2 is hard to understand. Please clarify by adding headers or labels to each of the 3 main parts of the Figure. (Steve Clemmer, Union of Concerned Scientists)	Noted Figure should be corrected. see also above comment A406
4-412	A	13	1	13	4	Figure 4.1.3, it may not be needed. You can explain in text. (Junichi Fujino, NIES)	Noted Probably Fig. 4.2.2 was meant. see also above comment A406
4-413	A	13	1	0	0	figure 4.2.2 (Also for many other charts) Labeling is unclear--can't tell which chart is which. (Joanna Lewis, Pew Center on Global Climate Change)	Noted Figure should be corrected. see also above comment A406
4-414	A	13	1	0	0	Figure 4.2.2: It is not clear what each of the situations here represent. Either name them a, b or c, or include titles, or make the caption clarify. (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted Figure should be corrected. see also above comment A406
4-415	A	13	1	13	0	Figure 4.2.2. This Figure is set of 3 figures. Each figure must has a subtitle i.e (i) without CCGT and fluorescent light bulb, (ii) with CCGT, (iii) with fluorescent	Noted Figure should be corrected.

						light bulb . There is need to change the order of the figures also. The middle picture (needs 320 units of primary energy), without CCGT and fluorescent light bulb, should be on top. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	see also above comment A406
4-416	A	13	1	13	4	The figure seems to be showing the following cases: (a) Conventional powerplant with CFL [because the wiring to lamp ratio is 10:1] (b) Conventional powerplant with incandescent lamp [wiring to lamp ratio is 5 times larger, or 50:1] (c) Combined cycle powerplant with incandescent lamp. However, this is not stated. Furthermore, these are not the most sensible combinations to show. Surely, the two extremes should be shown: Conventional with incandescent, and CC with CFL. Then, the relative reduction in energy use is a factor of 50/35 x 5 which is about a factor of 8 reduction, or a reduction by 88% (not 80%). Thus, the figure should be redone, even if that means departing from the original figure in the cited reference. (Danny Harvey, University of Toronto)	Noted Figure should be corrected. see also above comment A406
4-417	A	13	1	0	0	Figure 4.2.2. Not clear what these three scenarios represent. Better labelling required (Christine Copley, World Coal Institute)	Noted Figure should be corrected.
4-418	A	13	1	0	0	Figure 4,1,2 Delete the comment "This reduces the required energy by 80%" because it is not clear, move it in the text. (Stefano Caserini, Politecnico di Milano)	Rejected see also above comment A406
4-419	A	13	1	13	1	Figure 4.2.2 needs some clarification. The first two energy flow diagrams are for "Gas or Coal" with different "Loss" values. An explaination is required that what is the major difference between the two diagrams? Similarly the last Diagram is for "Gas". The Figure needs more explanation. Units for the values may also be specified. (Muhammad Latif, Applied Systems Analysis Group)	Noted Figure should be corrected. see also above comment A406
4-420	A	13	1	0	0	I would delete figure 4.2.2 or move it to Chapter 6. If you move it, it needs to be fixed. As it currently stands it does not show what you wanrt it to show, there are no units or explanation of which each of the three diagrams represent. (Michael Taylor, International Energy Agency)	Noted Figure should be corrected. see also above comment A406
4-421	A	13	1	13	1	Adopt for figure 4,2,2 a life cycle appraoch. If you want to compare lighting and CO2 emissions, the main difference comes from the electricity mix for comparing the emissions. You cannot compare with electricity from cogeneration attributing all emissions to heat. Lighting is and end use technology very different from electricity generation. So this figure is a non sens for me. To be delated.	Noted The figure shows an energy flow. see also above comment A406

						(DELLERO Nicole, AREVA)	
4-422	A	13	1	13	1	Adopt for figure 4,2,2 a life cycle appraoch. If you want to compare lighting and CO2 emissions, the main difference comes from the electricity mix for comparing the emissions. You cannot compare with electricity from cogeneration attributing all emissions to heat. Lighting is and end use technology very different from electricity generation. So this figure is a non sens for me. To be delated. (DELLERO Nicole, AREVA)	Duplicate of comment A442
4-423	A	13	1	13	0	Figure 4.2.2. Need to label graphic more clearly. This graphic appears to contradict its explanation. Labels to show which paths represent CCGT or fluorescent lighting vs. less efficient generation and incandescent lighting are needed. These paths appear to show that site wiring losses account for a 90% - 98% loss of energy when T&D losses in total are about 10%. Also, the last path is the one with the best conversion efficiency, so one would believe that it is the CCGT, yet it is the middle path for overall efficiency not the most efficient path. The graphic should be replaced. U.S. Government (Government of U.S. Department of State)	Noted Figure should be corrected. see also above comment A406
4-424	A	13	1	13	4	please add legends to each of the three pictures to make clear where to find conventional power generation and where to find CCGT as well conventional lamp and the energy saving lamp; the pictures shall be correctly scaled and the relevant differences shall be emphasized (Government of Germany)	Noted Figure should be corrected. see also above comment A406
4-425	A	13	2	0	0	Fig 4.2.2. Some of the labeling has been lost from this figure. By a process of deduction I conclude that the top line is for CCGT with low energy light bulb, but the figure does not say so. Similarly the other lines are not labeled. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Noted Figure should be corrected. see also above comment A406
4-426	A	13	2	0	4	The difference among 3 graphs is not represented. The top figure seems to be CCGT & compact fluorescent light bulb. The other 2 figures are ...? (Toshihiko Masui, National Institute for Environmental Studies)	Noted Figure should be corrected. see also above comment A406
4-427	A	13	3	13	3	Figure is unclear, especially since the main messages are not reflected in the text, can probably be deleted. (Government of European Community / European Commission)	Noted Figure should be corrected. see also above comment A406
4-428	A	13	9	0	0	I would suggest "occur, but are relatively modest." (Michael Taylor, International Energy Agency)	Taken into account

4-429	A	13	14	13	16	Update figures - latest BP review suggests fossil fuel share up to 87% (Christine Copley, World Coal Institute)	Accepted Figures should be updated.
4-430	A	13	15	0	0	This is presumably the root of the misleading statements elsewhere that the total share of fossil fuels dropped from 86% in 1971 to 80% in 2003 - whereas the share dropped below 80% by 2000 but has since risen. See BP 2006 et al. (Michael Jefferson, World Renewable Energy Network & Congresses)	Taken into account The temporal behaviour will be described more accurately
4-431	A	13	16	13	16	Please add reference for the numbers given in this sentence. (,)	Noted
4-432	A	13	18	13	18	The phrase "cooking and heating" can be changed to "cooking, space heating and water heating". (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	Accepted
4-433	A	13	0	13	0	Figure 4.2.2: What types of fossil fuel power are shown for each of three energy flows? Please describe it in the figure. However, it will be enough to show only one of the flows from the description in the main text (line 26-29, p. 11). (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Noted “Primary energy” may be amended by “natural gas”.
4-434	A	13	0	0	0	Figure 4.2.2 To "work" in this figure for their best understanding. (José Somoza, National Institute of Economic Research)	Rejected It is an energy flow.
4-435	A	13	0	13	0	Figure 4.2.2 is not very user friendly currently. It is suggested to further explain the numbers below the energy stages in figure 4.2.2 for the sake of clarity (e.g. 64, 22, 21, 20 etc), since it is not very clear that these represent primary energy. Apparently the figure has become more complicated since we are comparing the energy reductions due to supply and end-use demand side changes together wrt a reference case. It is suggested to label the 3 sub-figures as a, b and c, and to provide details in the caption below separately for each. Moreover, the losses may be heat loss as well (e.g. 90% at the lamp stage), which is again not very clearly indicated. We may not be in a position to reduce such losses, while the figure gives a general impression that losses could be undesirable (true) and could be reduced (may not be always possible). (Government of India)	Noted Figure should be corrected. see also above comment A406
4-436	A	14	1	0	0	Several energy sources listed in the the right hand legend of Figure 4.2.3 are not ploted as curves on the graph because they are so small. Either drop them from the legend or aggregate them in an "Other" category big enough to show up. (David Jackson, McMaster University)	Accepted

4-437	A	14	1	14	4	Figure 4.2.3, do you need solar phtovoltaics to other fuel sources on the figure? What is heat? (Junichi Fujino, NIES)	Taken into account „Heat“ should be deleted.
4-438	A	14	1	0	0	figure 4.2.3 How is primary energy of renewables determined? (Joanna Lewis, Pew Center on Global Climate Change)	Noted Different conversions practices (those of IEA) between primary energy and electricity are applied for hydro, wind and combustion based use of biomass products
4-439	A	14	1	14	3	What does “Heat” mean as a fuel source for primary energy? Heat is usually considered to be an energy product, not a source. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted „Heat“ should be deleted.
4-440	A	14	1	0	0	Figure 4.2.3. The difference between "Nuclear" and "Heat" is hard to understand under the current representation. Also, why not all of the categories listed appear in the main display requires explanation. (Government of Japan)	Taken into account. The same markers are erroneously used for both. „Heat“ should be deleted.
4-441	A	14	1	14	3	What does “Heat” mean as a fuel source for primary energy? Heat is usually considered to be an energy product, not a source. U.S. Government (Government of U.S. Department of State)	Accepted “Heat” should be deleted.
4-442	A	14	2	0	0	Figure 4.2.3. I am puzzled by this; what does heat mean as a primary energy source? (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Accepted “Heat” should be deleted.
4-14	B	14	4	14	4	In Fig 4.2.1 there is no growth rate visible. Delete cross reference. (Government of Germany)	Accepted Cross reference should be deleted.
4-443	A	14	4	14	4	The text "an average growth rate of 2.8%/yr since 1995 (see Figure 4.2.1)" is not correct. The referred Figure (4.2.1) shows only the energy flow for the year 2003. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	Accepted “see Figure 4.2.1” should be deleted. and reference to another information source be added
4-444	A	14	6	14	10	Update figures - IEA's Key World Energy Statistics 2006 states coal 40%, natural gas 20%, nuclear 16% , hydro 16, oil 7 and renewables 2.1%. http://www.iea.org/textbase/nppdf/free/2006/key2006.pdf (Christine Copley, World Coal Institute)	Accepted
4-445	A	14	6	14	8	Strike this sentence and insert in its place the following: “Some research suggests potential offsets from dedicated bioenergy crops and forest products (not covered by agricultural and forestry mitigation) of about 2.2 GtCO2-eq/yr” by 2030 at costs	Rejected (here) The original sentence is useful here. There is a description about cost in another section.

						<U.S.$50/ tCO2-eq, though the evidence is limited." U.S. Government (Government of U.S. Department of State)	The suggestion will be considered in that section
4-446	A	14	6	14	6	"coal plus lignite" - Lignite is a type of coal. U.S. Government (Government of U.S. Department of State)	Taken into account It should be amended to a more accurate expression (e.g. hard coal and lignite).
4-447	A	14	9	0	0	Should read "growing by 10%" (Danny Harvey, University of Toronto)	Noted
4-448	A	14	12	0	0	I would suggest "Many consumers of petroleum, and to a lesser extent gas, depend to….." Security of gas supplies is not as wide an issue as for oil at this time, but will grow in importance. (Michael Taylor, International Energy Agency)	Taken into account
4-449	A	14	12	14	19	This paragraph refers the status of both petroleum and natural gas. We recommend to separate this sentence for each topic, as the situation on petroleum and on natural gas is quite different. (Government of Japan)	Noted
4-450	A	14	16	14	19	What about the Middle East? Also experiencing political unrest but not mentioned here. U.S. Government (Government of U.S. Department of State)	Taken into account Middle East needs to be included.
4-451	A	14	17	4	18	Vulnerability of supply was not INCREASED by political unrest, as written in the text. The situation is different: political unrest is a basic criterion of vulnerability. It would be better to write: "(...sent prices higher and) and showed the vulnerability of supply." (Nikolaus Supersberger, Wuppertal Institute for Climate Environment Energy)	Noted
4-452	A	14	18	0	0	"Expands" (Heleen de Coninck, Energy research Centre of the Netherlands)	Accepted
4-453	A	14	18	0	0	This a tricky problem and needs to be stated more clearly. Increased imports don't increase the risk supply disruption, but they do make the consequences more dramatic. I think what you want to say is that "increased international trade will mean that supply disruptions may have more serious impacts than currently. The idea being that more exports from Saudi Arabia doesn't increase the risk of a disruption, but makes the consequences more serious. (Michael Taylor, International Energy Agency)	Taken into account
4-454	A	14	18	14	19	It is not clear from the wording here that the risks of supply disruption include fundamental recoverable resource constraints on conventional oil.	Taken into account see also above comment A453

						(Michael Jefferson, World Renewable Energy Network & Congresses)	
4-455	A	14	20	14	25	In the text there is no comments about nuclear wastes storage costs (Félix Hernández, Economía y Geografía. Consejo Superior de Investigaciones Científicas (IEG-CSIC))	Noted The full fuel cycle costs (incl. back end and decommissioning) are included in projected cost evaluation presented in Fig. 4.4.3; page 77.
4-456	A	14	21	14	23	Investment uncertainties for nuclear exist due to unclear governmental policies and (perceived) lack of government support for nuclear. These regulatory risks translate into tightened and more stringent requirements from financial markets in order to cover such risks. This may result in higher interest rates, thus increasing costs of capital and thereby generation costs. (Walter Ruijgrok, EnergieNed)	Taken into account The unclear governmental policies could be mentioned as an additional (original) reason to perceived risks
4-457	A	14	21	14	25	Concerns about nuclear also include waste storage and proliferation. (Joanna Lewis, Pew Center on Global Climate Change)	Noted There is a description about issues related to nuclear waste management and disposal as well as to proliferation in section 4.3.2.3.
4-458	A	14	21	15	5	The question of whether price-stable electricity sources reduces risks is a question of "whose risks"? From the point of view of the country, a renewable source of electricity (or a nuclear station) does reduce the overall risk from fluctuating fuel prices. This is also true for consumers who can invest in a reliable source of power (and so applied for the Finnish consumers financing the new nuclear station at Olkiluoto 3), although most renewables imply a quantity risk. However, a company that invests in a stable-cost source of power in a liberalised electricity market is actually exposing itself to more risk, than if it invested in whichever fossil-fuelled power station typically sets the wholesale price at the margin. In the UK, for example, power prices typically follow gas prices, and so the margin between your selling price and the cost of your fuel (for a gas station) is pretty constant. The margin between wholesale electricity prices and nuclear power costs is very risky - look at what has happened to British Energy's finances over the last few years. (near-bankruptcy followed by very healthy cash surpluses) (Richard Green, University of Birmingham)	Rejected (here) This kind of discussion may be dealt with in another (sub)chapter.
4-459	A	14	21	15	5	Sources for this are Roques, F.A., W. J. Nuttall, D.M. Newbery, R. de Neufville and S. Connors (2006) "Nuclear Power: a Hedge against Uncertain Gas and Carbon Prices?" The Energy Journal vol. 27 no. 4, pp 1-23 and perhaps Green, R.J. (2006) "Carbon	Noted see above comment A458

						tax or carbon permits: the impact on generators' risks" British Institute for Energy Economics Conference, September 2006 (which I plan to get on a Birmingham web site very soon). A possible textual insertion that would cover this point would be (just before Awerbuch, 2006) "unless their owner also has to sell at the volatile fossil fuel price", inserting Roques et al 2006 in the brackets and the references (Richard Green, University of Birmingham)	
4-460	A	14	21	14	25	In this whole section, there is no mention of the very high capital costs of nuclear. It seems like an important thing to include. (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted maybe using rephrasing "further increasing the large share of capital costs"
4-461	A	14	21	14	25	Other large, capital intensive projects, such as IGCC (and possibly hydro), face similar financing hurdles. These are due primarily to longer construction periods and high initial levels of capital investment required. Uranium is also a relatively stable fuel source and represents a low fraction of nuclear generating costs, which makes electricity generated from nuclear more stable in terms of price. U.S. Government (Government of U.S. Department of State)	Noted There is not a need to have an exhaustive discussion here (see section 4.4.2)
4-462	A	14	22	14	22	suggest omission of the word 'perceived'. The risks are real, i.e., Chernobyl, etc., the uncertainties over liability and waste disposal; and that is what is reflected in private insurance companies being unwilling to insure nuclear power plants (Steve Sawyer, Greenpeace International)	Rejected Here the "perceived risk" is referring primarily to financial risks and not to the accident risk. The latter belongs to the discussion under section 4.3.2.2
4-463	A	14	24	0	0	Surplus of uranium supply is highly unlikely as the current production volume already relies on non-civil sources and commercially available uranium is limited (see IAEA and Greenpeace: Uranium Report 2005) (Sven Teske, Greenpeace International)	Noted In the present situation this possibility of uranium supply exceeding the demand is unlikely. However, in the future other projections of supply and price may realize as well.There are various projection on this matter.
4-464	A	14	47	15	2	There are national / regional (e.g. Europe) scenarios showing that the share of renewables can be much higher in 2030 (e.g. Greenpeace Report (2005): „Energy revolution: A sustainable pathway to a clean energy future for Europe") (Gabriela Von Goerne, Greenpeace)	Rejected Cannot be accepted. The discussion of possible increased shares of different sources (incl. renewables) is another sections of Ch 4.
4-465	A	15	0	15	0	"However funding for energy research has been flat or declining for over two	Noted

						decades. The level of R&D in energy technologies is low compared with other industries, but massive changes will be required to meet the long-term goals of CO2 mitigation, such as the production of 500 EJ/year of non-CO2-emitting primary energy by 2100. Long-term, large scale, high-risk, high benefit energy research is not rewarded in the private market, and must be supported by governments. The international ITER project, in which China, the European Union, India, Japan, Russia, South Korea and the United States are joining to demonstrate the scientific and technological feasibility of fusion energy, is a good example of such investment." U.S. Government (Government of U.S. Department of State)	Energy research need and benefits are discussed in other sections (4.6). This suggestion could be reflected there.
4-466	A	15	1	15	9	What is your point here, you say that renewable prices are uncertain in first sentence, and then that they are stable in the second? One statement isn't true. Would it be better to say that annual generation from renewables, and hence the cost of generation in that year can vary due to a number of reasons, but that over the lifetime of the capital item and estimate of the average generation cost can be estimated with reasonable certainty. (Michael Taylor, International Energy Agency)	Taken into account More correct description may be needed. taking into account that annual fluctuations of e.g. crop yields do not affect significantly on the competitiveness over longer timescales
4-467	A	15	2	15	5	These two sentences appear to contradict themselves on the one hand renewables are discussed in terms of uncertainties and then the next sentence they are called price-stable sources in terms of avoiding losses from oil prices and power prices yet for power prices renewables will be a source for power. I suggest rewriting this sentence to reflect that renewables offer a degree of certainty depending on the right climatic conditions. (John Kessels, Energy Research Centre of the Netherlands)	Noted More correct description may be needed. see above comment A466
4-468	A	15	2	15	4	The sentence is wrong. There is no price uncertainty from renewables, except biomass. There is production uncertainty in individual years, which are smoothed out over the life of the plant but it has no effect on prices or production costs. The point to make is that production cost of zero-fuel renewables are known within a very narrow band at the beginning of the project. Technologies that depends on fuels at uncertain and predictable prices can never be known at the outset of the project and there is no possibility of fully hedging that price risk in the markets. (Christian Kjaer, European Wind Energy Association)	Noted More correct description may be needed. see above comment A466
4-469	A	15	2	15	4	Delete the whole 2nd sentences in line 4; "However, investing in .. .. .. oil and power prices (Awerbuch, 2005)" <Rationale>	Noted More correct description may be needed. see above comment A466

						This sentence contradicts to the 1st sentence which mentions that the price of the renewables are uncertain. Actually, even biomass power generation is also affected by the oil prices. (Shigeo Murayama, The Federation of Electric Power Companies)	
4-470	A	15	2	15	3	"Modify text to clarify capital versus other costs. U.S. Government (Government of U.S. Department of State)	Noted More correct description may be needed.
4-471	A	15	5	15	5	should be '…fluctuating oil, gas and power prices…" (Steve Sawyer, Greenpeace International)	Noted More correct description may be needed.
4-472	A	15	5	15	8	China in 2005' a questionable comment. China's coal-fired power programme is more likely to be as a result of it's large indigenous resources and expertise than oil price (Christine Copley, World Coal Institute)	Noted More correct description may be needed. Indegenousity of coal (hence more stable domestic price) needs to be mentioned.
4-473	A	15	7	15	8	should be '…This might lead to a reduction in transportation GHG emissions, although there is little evidence of it yet, but certainly leads to an increase in the attractiveness of renewable energy technologies which now can compete with gas. (Steve Sawyer, Greenpeace International)	Noted Renewables can be mentioned. However, more price-stable indigenous fossil fuel (coal in China) are obstacles for increased use of renewables
4-474	A	15	8	0	0	To my mind China has never planned a significant share of its electricity production from burning of oil. If the meaning of '(China in 2005)' is that they had planned that, I wonder if that's valid. If not, skip it to '…shift to coal-fired power plants. Hence, high energy ...' (Manfred Treber, Germanwatch)	Taken into account China is not the best example in this context
4-15	B	15	18	15	20	The authors should explain why Oceania was excluded from this figure. (Government of Australia)	Taken into account Oceania is included in Asia.

4-475	A	15	8	15	8	"(China in 2005)" should be omitted, as a) there is no evidence offered to support the fact that the large number of coal fired power plants that came on line in China in 2005 had anything to do with the recent price increases in oil and gas; b) they would have come on line in response to projected growth in demand several years previously due to projected and actual rapid economic growth. (Steve Sawyer, Greenpeace International)	Taken into account see above comment A474
4-476	A	15	8	0	0	"encourage a shift to coal-fired power plants (China in 2005)": this statement needs a reference or should be explained better. Oil is hardly used in the electricity sector, so why would high oil prices lead to a shift to coal?	Taken into account see above comment A474

						(Heleen de Coninck, Energy research Centre of the Netherlands)	
4-477	A	15	8	15	9	The conclusion that higher oil prices do not necessarily translate to lower GHG emissions is an important one, but it is not reflected in the Executive Summary, where increasing oil price is seen only as a factor that may increase the incentives to deploy carbon-free to low-carbon energy sources (Pg. 3, line 9). The Executive Summary should also include the concern that higher oil prices will increase dependence on national supplies of coal and lignite in countries (e.g. China) that have abundant supplies of these fuels. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Taken into account Suggestion regarding executive summary OK It is doubtful whether oil/gas price fluctuations are reflected notably to the use of domestic coal in China
4-478	A	15	8	15	9	The conclusion that higher oil prices do not necessarily translate to lower GHG emissions is an important one, but it is not reflected in the Executive Summary, where increasing oil price is seen only as a factor that may increase the incentives to deploy carbon-free to low-carbon energy sources (Pg. 3, line 9). The Executive Summary should also include the concern that higher oil prices will increase dependence on national supplies of coal and lignite in countries (e.g. China) that have abundant supplies of these fuels. U.S. Government (Government of U.S. Department of State)	Taken into account Duplicate comment to A477
4-479	A	15	8	15	0	“shift to non CCS coal generation (China in 2005)” text should be reworded. U.S. Government (Government of U.S. Department of State)	Taken into account
4-480	A	15	13	15	13	Update figures. IEA Key World Energy Statistics show global primary energy supply at 11059 Mtoe (464.5 EJ) http://www.iea.org/textbase/nppdf/free/2006/key2006.pdf (Christine Copley, World Coal Institute)	Accepted
4-481	A	15	15	0	0	This statement is incorrect or at the very least misleading, the reduced rate of energy consumption between 1990 and 2002 almost certainly was not do to energy and conservation efficiency improvements in OECD countries. In fact energy intensity improvements in the 90's were probably around half the levels of between 1971 and 1990 (see IEA 2004 "30 Years of Energy Use in IEA Countries: Oil Crises and Climate Challenges. A better sentence would be "The slowing in the rate of energy consumption was due to the reduction in energy consumption in the FSU and slightly slower global GDP growth, this is depsite a decline in improvement in energy intensity in IEA countries (IEA, 2004)". (Michael Taylor, International Energy Agency)	Noted Effect of slower GDP growth and efficiency improvement in OECD countries should be mentioned. The suggested formulation regarding FSU etc can be considered
4-482	A	15	17	15	17	Change the word "and" by "whereas".	Accepted

						(José Somoza, National Institute of Economic Research)	
4-483	A	16	0	16	0	Figure 4.2.5, add "measure units" (José Somoza, National Institute of Economic Research)	Accepted
4-484	A	16	1	16	2	My impression is that it sounds too causal to read '… low electrification rates equate to slow socio-economic development.' Logically more correct is '… low electrification rates correlate with slow socio-economic development …' Compare also with page 20 lines 15 and 16 in this chapter. (Manfred Treber, Germanwatch)	Taken into account
4-485	A	16	2	0	0	There are some very powerful plots of Human Development Index HDI against both total energy and electricity use per capita which would emphasis the importance of energy to economic development and social progress, for example those by Smil. (Chris Mottershead, BP)	Rejected This section focuses on a description of energy and CO2.
4-486	A	16	4	16	4	"There is large discrepancy ….". Change 'discrepancy' to 'disparity'. This comment assumes that there is no inconsistency in the quoted database. (Government of India)	Accepted
4-487	A	16	4	16	4	Change "discrepancy" to "disparity". U.S. Government (Government of U.S. Department of State)	Accepted
4-488	A	16	9	0	0	Suggest hang new footnote from "Emission" to read "In principle net emissions i.e. emissions net of absorption - in this chapter absorption is relevant only in relation to biofuels" (Peter Read, Massey University)	Rejected Instead of a footnote one can consider to mention "absorption" in the text as relevant to biofuels
4-489	A	16	9	16	9	Suggest hang new footnote from "Emission" to read "In principle net emissions i.e. emissions net of absorption - in this chapter absorption is relevant only in relation to biofuels" (Peter Read, Massey University)	Rejected Duplicate to A488
4-490	A	16	9	16	0	Is section 4.2.2 Emission trends – all gases covered elsewhere? U.S. Government (Government of U.S. Department of State)	Taken into account "Emission trends of GHG" seems better.
4-491	A	16	11	16	19	Section 4.2.2 contains too many reference years, hence the analysis, though correct, is confusing. Also, why identify only Braziul? Is this because Brazil's carbon emmission was too high? (Ajay Guha, Asian Development Bank)	Rejected The information in references fixes the reference years. Brasil is only one example among many others.
4-492	A	16	11	16	13	The description of "Emission data can be found on the UNFCCC and European	Taken into account

						Environment Agency web sites." is inconsistent with the source of Figure 4.2.5. (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Source of Figure should be investigated again.
4-493	A	16	11	17	31	Section 4.2.2 In this section I would propose to present the performance of the global emissions of carbon in the USA, the main GHG emitting country. (José Somoza, National Institute of Economic Research)	Rejected The main approach is not to mention emissions in individual countries, but USA could be an exception.
4-494	A	16	11	16	28	For Section 4.2.2 Emission trends-all gases, too much space has been given to China. It is imbalanced. China's emission has already included in Asia and Pacific countries, and it is not necessary to add one separate paragraph to state China's emission. Further, knowing the revising of China's GDP growth by the Government, the information on China's CO2 emission from the references is not accurate. The paragraph should be deleted. (Government of China Meteorological Administration)	Noted China has higher than average emissions within Asia and Pacific. More accurate data is needed.
4-495	A	16	11	16	12	"Global carbon emissions stabilized after the two oil crises in 1973 and 1979 and then growth continued (Figure 4.2.5), averaging 1.9% /yr during the period 1990-2003." The referenced Figure 4.2.5 shows emission trends by region, but does not show a global total. Suggest adding a global total line to the Figure, in order that the statement can be supported. Also, the use of the word "stabilized" in line 11 is not a good description of a relatively short-lived response. Suggest that the sentence be rephrased as "Global carbon emissions temporarily leveled off after the two oil crises in 1973 and 1979, followed by a resumption in growth …" Graph should be updated to include data beyond 2002. U.S. Government (Government of U.S. Department of State)	Taken into account The global total line could be considered to be added to the figure.
4-496	A	16	15	0	0	BP emissions data to 2005 have been available since June 2006. (Michael Jefferson, World Renewable Energy Network & Congresses)	Taken into account Update
4-497	A	16	16	0	0	did total carbon emissions increase by 6.5% between 1990 and 2003, if so, say so. (Michael Taylor, International Energy Agency)	Accepted More correct description
4-498	A	16	19	16	0	delete extra "and" (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-499	A	16	20	16	21	What are the y-axis units for this graph, Figure 4.2.5? (James Dooley, Battelle)	Taken into account
4-500	A	16	21	0	0	Figure 4.2.5. What are the units on the vertical axis? It is not possible to follow the sense of the text in the diagram either.	Taken into account

						(Stanley Gordelier, Nuclear Energy Agency of the OECD)	
4-501	A	16	21	0	0	Figure 4.2.5: Please add the unit of the y-axis (I assume it is Gt CO2 equivalent) (Manfred Treber, Germanwatch)	Taken into account
4-502	A	16	21	0	0	figure 4.2.5 Would be nice also to see a graph of total global emissions trend. (Joanna Lewis, Pew Center on Global Climate Change)	Taken into account
4-503	A	16	21	0	0	The caption should clarify whether this is CO2 or includes other GHG. The title of the para says it, but the text not. (Heleen de Coninck, Energy research Centre of the Netherlands)	Taken into account
4-504	A	16	21	16	22	Units of Carbon Emissions are missing in Figure 4.2.5. (Muhammad Latif, Applied Systems Analysis Group)	Taken into account
4-505	A	16	21	16	0	Figure 4.2.5: What emissions are included in the figure? All the CO2 emissions which can be imagined from the figure title, CO2 emissions from energy supply which can be imagined from chapter title, all the GHG emissions which can be imagined from the section title, or? The unit of the vertical axis is also not shown. Please describe them explicitly. In addition, is this consistent with Figure 1.1, if the emissions include all the GHGs (the source is different from Figure 1.1)? (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Taken into account Clarification needed. Consistency with Fig. 1.1 will be cked
4-506	A	16	22	0	0	You need to add a unit of measurement to the Y axis of figure 4.2.5 (Michael Taylor, International Energy Agency)	Taken into account
4-16	B	16	22	16	28	The authors should explain why only China is used as an example for declining carbon intensities. (Government of Australia)	Accepted Sentences from 23-28 shall be rewritten.
4-507	A	16	23	16	0	Figure 4.2.5. Labeling of the units for the y-axis is needed. U.S. Government (Government of U.S. Department of State)	Taken into account
4-508	A	16	28	0	0	China's CO2 emissions from fossil fuel use at 1,491million tonnes in 2005 represented 18.7% of the World total in 2005. [Figures include China Hong Kong SAR]. Source: BP, 2006. The IEEJ data are very different, and seem well out-of-date. (Michael Jefferson, World Renewable Energy Network & Congresses)	Taken into account Data should be updated.
4-509	A	17	2	17	2	should be Delhotal, not "Delahotel" (Katherine Casey Delhotal, Research Trinagle Institute)	Accepted
4-510	A	17	2	17	2	Most recent literature for non-CO2 GHGs not cited in this chapter. additional references for methane emission projections and mitigation: 1) Global	Taken into account

						Anthropogenic Non-CO2 Greenhouse Gas Emissions: 1990–2020, USEPA, Washington, DC, 2006, http://www.epa.gov/nonco2/econ-inv/international.html. 2) Global Mitigation of Non-CO2 Greenhouse Gases, USEPA, Washington, DC, 2006, http://www.epa.gov/nonco2/econ-inv/international.html. 3) Delhotal et al, Mitigation of Methane and Nitrous Oxide Emissions from Waste, Energy and Industry, Energy Journal, 2006, in press. U.S. Government (Government of U.S. Department of State)	
4-511	A	17	8	15	17	I am a bit confused you appear to be writing about Coalmine Methane as well as coalbed methane? To be clear there are three ways in which coalbed methane is recovered from coal seams, first drainage from working coal mines (coalmine methane CMM), extraction from abandoned coal mines or abandoned mine methane AMM), and production from unmined coal using surface boreholes or coalbed methane CBM).I refer you to Lesley L Sloss, 2005 Coalbed Methane Emissions- capture and utilisation, IEA Clean Coal Centre, London, UK ISBN 92-9209-420-5. I am happy to send a copy of the report. (John Kessels, Energy Research Centre of the Netherlands)	Noted
4-512	A	17	8	17	8	CBM section is not 4.3.2.2, is it 4.3.1.2 under the section heading Methane Fuels? (John Kessels, Energy Research Centre of the Netherlands)	Accepted You are right. Section is changed.
4-513	A	17	8	17	15	The Methane to Markets programme is mentioned in the Technical Summary but not here. There are many CBM projects ongoing worldwide, and it has an approved methodology under the CDM. China, Australia, and Poland in particular host numerous projects at active mines while Germany and the United States host several projects at both active and abandoned mines. Though they have not developed any projects, Mexico, India, New Zealand, and South Africa have conducted methane drainage in addition to ventilation at active coal mines while Italy is currently assessing the feasibility of drainage at an abandoned mine. These countries have strong potential to recover and utilize drained gas in the future. In fact, a project in India to use recovered CMM for power generation and as fuel for vehicles is in the planning phase.an estimated total of 36 MMt CO2e are recovered from Methane to Markets partner countries annually.	Noted needs to mentioned briefly here, but this lengthy discussion is beyond the reasonable size of this subsection

						(Christine Copley, World Coal Institute)	
4-514	A	17	11	17	15	Suggest including more recent EPA references for methane emission projections and mitigation: Global Anthropogenic Non-CO2 Greenhouse Gas. Emissions: 1990–2020, USEPA, Washington, DC, 2006. Global Mitigation of Non-CO2 Greenhouse Gases, USEPA, Washington, DC, 2006. http://www.epa.gov/nonco2/econ-inv/international.html U.S. Government (Government of U.S. Department of State)	Taken into account
4-17	B	17	12	17	14	The quoted coal-bed methane emission levels for 2000 seem low. In particular, according to the United States 2003 emission inventory, CH4 emissions from coal mining and abandoned coal mines in the year 2000 were 2677 and 369 (= 3046) kt CH4. Using a GWP of 21 this equates to an emission level of approximately 64 Mt CO2-e - significantly higher than the quoted 36 Mt CO2-e in the report. The authors should review these numbers. (Government of Australia)	Taken into account Data should be checked. Ask to get reference
4-515	A	17	17	17	28	In case my suggestion above (=A2) was not acceptable I ask to modify as follows: Other greenhouse gases are produced by the energy sector but in relatively low volumes.SF6 is widely used in lectrical equipment for electricity transmission and distribution because of its unique electrical insulating and switching properties.One hand there is its high GWP of 22.200 and its high natural lifetime in the atmosphere. Other hand it allows for extremely compact design (compared to conventional equipment types) thus indirectly helping to reduce transmission and distribution losses and contributing to conserving resources by an significantly extended service life. Various voluntary action programs and commitments by the industry have successfully reduced emissions from all life cycles and continue to further improve the situation:State of art equipment supplied from the mid 1990-ties is extremely tight with leakage rates below 0,5% for high voltage and below 0,1% per year for medium voltage equipment requiring no or maximum one gas handling action during its entire lifetime of 40 to 50 years.More compact design steadily reduces gas charges. Modern gas handling equipment and processes allow for almost 100% recovery particularly at end of life.The European electrical industry reduced SF6 emissions from electrical equipment by 50% between 1995 and 2003 (J.Harnisch and S.Wartmann, 2005) comparing to the European Commission's target for EU 15 on fluorinated GHG for 2010 which is to keep the 1995's level. This was achieved due to early voluntary industry actions and various national voluntary commitments of the relevant industry associations of equipment	Taken into account see next comment for suggested modification

						manufacturers and utilities providing specific targets and transparency to stakeholders through verification by reporting systems. As an example the negotiated renewed German voluntary commitment is attached. A similar voluntary commitment exists in Japan (Yasutake and Meguro, 2002)--attached. Further inn the US the government formed a partnership with 62 electric power generators and utilities (representing about 35% of the US power grid) to voluntarily reduce emissionsfrom electrical equipment. The release rate dropped from 17% of stocks to 9% between 1999 and 2002. (Friedrich Plöger, Siemens AG)	
4-516	A	17	17	17	28	Following my general recommendation above the whole text could be modified as follows: Other greenhouse gases are produced by the energy sector but in relatively low volumes.SF6 is widely used in lectrical equipment for electricity transmission and distribution because of its unique electrical insulating and switching properties. Further details as well as mitigation activities by the industry are included in chapters 7.4.8. and 7.9.2 (Friedrich Plöger, Siemens AG)	Taken into account
4-517	A	17	17	17	22	No reference is made to SF6 emissions from aluminium smelting. Also, shouldn't Iceland's woeful performance in this regard be highlighted? (Michael Jefferson, World Renewable Energy Network & Congresses)	Taken into account Reference should be needed.
4-518	A	17	17	17	31	This paragraph contains a brief discussion of emissions of SF6 from electrical equipment, but it discusses emissions from only a few countries. Also, it states that SF6 is "produced" by the energy sector, which it is not. A more complete discussion of SF6 emissions from electrical equipment occurs on page 35 and 36 of Chapter 7. Recommend that the Chapter 4 authors refer to that discussion, and that they shorten the discussion in Chapter 4 by deleting the text that begins "Approximately" on line 21 and ends with "rates" on line 28. The attached revision??? implements these changes. U.S. Government (Government of U.S. Department of State)	Taken into account The comment may be acceptable. Where one can find the" attached revision"??
4-519	A	17	20	0	0	Replace "and it has a" with ", due in part to its" (Danny Harvey, University of Toronto)	Accepted
4-520	A	17	26	0	0	Should read "Australia, The Netherlands, and other countries also …" (Danny Harvey, University of Toronto)	Accepted
4-521	A	17	26	17	31	Suggest including more recent EPA references for SF6 emission projections and mitigation: 1) Global Anthropogenic Non-CO2 Greenhouse GasEmissions: 1990–2020, USEPA, Washington, DC, 2006. 2) Global Mitigation of Non-CO2	Taken into account

						Greenhouse Gases, USEPA, Washington, DC, 2006. http://www.epa.gov/nonco2/econ-inv/international.html U.S. Government (Government of U.S. Department of State)	
4-522	A	17	29	17	31	This sentence is a bit of an open door - all non-CO2 GHG have a small contribution compared to CO2. Better mention what is the contribution (Heleen de Coninck, Energy research Centre of the Netherlands)	Taken into account
4-523	A	17	29	0	0	The information on N20 is limited, but there should be more available. How much N2O is produced? What is the future trend for methane emissions? (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted Quantitative information would be useful, in case relevant reference could be found. Are there any data on N2O?
4-524	A	17	30	17	30	CFC 114 is used as a coolant in different industries and may be used in other types of plants for cooling. Delate the sentence et replace by :"The use of CFC 114 has been reported in some gaseous diffusion enrichement plants (Dones et al 2005). Nowadays, technology for enrichement is turning to centrifugation." (DELLERO Nicole, AREVA)	Taken into accout
4-525	A	17	30	17	30	CFC 114 is used as a coolant in different industries and may be used in other types of plants for cooling. Delate the sentence et replace by :"The use of CFC 114 has been reported in some gaseous diffusion enrichement plants (Dones et al 2005). Nowadays, technology for enrichement is turning to centrifugation." (DELLERO Nicole, AREVA)	Taken into account
4-526	A	17	33	21	0	The section suffers from a much varying state of precision. E.g., on page 19, lines 4 and 8, ranges are mentioned, which appears to be appropriate, but do we need the two decimals in 18.35 - 55.05 GtCO2/yr? Same in line 16, is it useful to report China's economic growth as 9.67%? On page 20, one number is mentioned: 2400 GW; should this not be a range? (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted less accuracy is sufficient (undue accuracy was introduced in unit conversion!)
4-527	A	17	35	17	35	insert on between based A1 to read based on A1 (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-528	A	17	35	17	42	The data that are presented in this paragraph don't coincide, particularly those for demand of primary energy projected for the 2030, with the table 4.2.1. Please, to revise the data of the text and table. (José Somoza, National Institute of Economic Research)	Taken into account Consistency will be checked
4-529	A	17	35	17	42	Should be more careful in the use of "regionalization"; in places the IEA's World Energy Outlook 2004 regional break-out is used, but not in others. Rationale: It is	Taken into account Consistent use of "IEA regions" will be

						somewhat confusing to the reader if different aggregations are used. It seems in some parts of the report, North America includes Mexico, but not in this paragraph. Since the IEA's forecast is mostly cited throughout the report, consistent use of their regions would be helpful. U.S. Government (Government of U.S. Department of State)	aimed at.
4-530	A	17	37	0	0	Insert "that" after "show" (Danny Harvey, University of Toronto)	Accepted
4-18	B	18	1	18	50	The authors should explain why international marine bunkers are captured in Table 4.2.1, when such analysis more properly belongs in chapter 5. (Government of Australia)	Taken into account They are not included in any region. They should be specified in the energy data.
4-531	A	18	1	18	0	When adding the Emissions MtCO2 totals, International marine bunkers are not included in the World total? (John Kessels, Energy Research Centre of the Netherlands)	Taken into account They are not included in any region. They should be specified in the energy data.
4-532	A	18	1	18	0	I don't think these scenarios include the non-CO2 (or that was the impression I got from Lynn Price). It should be clear whether or not the scenarios include methane or SF6 (Katherine Casey Delhotal, Research Trinagle Institute)	Rejected Just CO2 emissions Exclusion of non-CO2 can be stated
4-533	A	19	1	19	10	What is the name and year of the WEC projected data this paragraph is refering too. (John Kessels, Energy Research Centre of the Netherlands)	Taken into account Notify reference cited.
4-534	A	19	1	19	10	You could add IEA Energy Technology Perspectives results to this paragraph by adding "The IEA (2006) projected that under a Baseline Scenario with no new policy measures global CO2 emissions would increase to around 58 Gt CO2 by 2050 due to continued energy demand growth, the increased share of coal and non-conventional oil. Alternative scenarios that include strong, co-ordinated global action to mitigate GHG emissions result in CO2 emissions in 2050 of between 20 and 31 GT CO2 in 2050 (IEA 2006, Energy Technology Perspectives). (Michael Taylor, International Energy Agency)	Taken into account Data should be updated.
4-535	A	19	5	19	5	Mistake in "This presents difficulties for the energy-supply side to meet energy resource growth." It should read "to meet energy demand growth." (Christian Kjaer, European Wind Energy Association)	Noted
4-536	A	19	9	0	0	Delete "in needing" (Danny Harvey, University of Toronto)	Accepted
4-537	A	19	11	19	20	China seems to be heading towards disaster. (Ajay Guha, Asian Development Bank)	Rejected Expression is enough.

4-538	A	19	12	19	14	It is not thought that oil is “now the largest source of primary commercial energy consumption in the Asia Pacific.” Rationale: Regardless of how you define Asia-Pacific, according to the EIA’s International Energy Annual 2004, in 2004 coal still provides 63 quadrillion Btu of the region’s consumption; oil only 48 quads. U.S. Government (Government of U.S. Department of State)	Taken into account You are right. Description should be amended.
4-539	A	19	16	0	0	I don't believe that Chinas economic statistics is that accurate so that you can trust a three-digit-number like 9,67%/a. Please don' t pretend accuracy where it it not there and make truncation: ' …growth of 9.7% from …' (Manfred Treber, Germanwatch)	Accepted Figure should be amended.
4-540	A	19	17	19	20	This is ambiguous. Do the pollution figures quoted refer to energy use or solely to coal. The statement cannot be verified as the reference URL points only to the most recent Statistical Review, and this data is not included in the printed report. (Christine Copley, World Coal Institute)	Noted Figures should be checked.
4-541	A	19	22	19	24	Update statistics. BP 2006 suggests 10% in Asia Pacific, 24% USA and 25% Europe (Christine Copley, World Coal Institute)	Accepted
4-542	A	19	22	19	25	Might want to update the BP source to 2006. Rationale: The 2004 BP report is a little dated. U.S. Government (Government of U.S. Department of State)	Accepted
4-543	A	19	24	0	0	Suggest you use the phrase "a more diverse liquified natural gas (LNG) market…." given that Japan has been importing LNG for many years now, they can't really be described as emerging. (Michael Taylor, International Energy Agency)	Taken into account
4-19	B	19	24	19	25	It would be useful for the authors to include the total size of world wide trade in LNG. (Government of Australia)	Taken into account The data must be investigated.
4-544	A	19	24	19	25	Suggest the phrase “has recently emerged” to describe the LNG markets in Asia. Rationale: The market has been dominated by the Asian importers Japan, Taiwan, and South Korea for some time. U.S. Government (Government of U.S. Department of State)	Taken into account
4-545	A	19	30	0	0	Perhaps you should talk about greater need for imports, rather than shortages, seeing as if there is a functioning market there should not be any sustained shortages, unless they arise from unforseen circumstances (natural disasters,	Noted Modification is not needed.

						industrial accidents etc) (Michael Taylor, International Energy Agency)	
4-546	A	19	30	20	7	What of conserving natural resources ? U.S. Government (Government of U.S. Department of State)	Noted Modification is not needed.
4-547	A	19	31	0	0	Delete “both” (Danny Harvey, University of Toronto)	Accepted
4-548	A	19	32	19	36	Energy security goals are sometimes in conflict with GHG emissions reductions goals. (Government of U.S. Department of State)	Noted Modification is not needed.
4-549	A	19	40	0	0	The trend continued to 2005 (ref. is only made to 2000-2002), with Uzbekistan the only such country registering a fall in the later period. (Michael Jefferson, World Renewable Energy Network & Congresses)	Noted If amended, reference is required.
4-550	A	19	42	0	0	Russia is not characterised by high dependancy on fossil fuel imports, you should change this sentence a bit. (Michael Taylor, International Energy Agency)	Taken into account Change the sentence a bit.
4-551	A	19	44	19	44	Delete para break (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-552	A	19	44	0	0	remove [no para. break] (Heleen de Coninck, Energy research Centre of the Netherlands)	Accepted
4-553	A	19	44	19	44	Typo to be cleaned (Government of France)	Accepted
4-554	A	20	4	20	5	This sentence is incomplete (Ajay Guha, Asian Development Bank)	Noted Add “relative” before “share”
4-555	A	20	9	20	9	To add: "…, implementation of CDM and …" (José Somoza, National Institute of Economic Research)	Accepted
4-556	A	20	10	20	10	Change "...will continue to play a role…" by "...will play a more activate (or dinamic) rol…" (José Somoza, National Institute of Economic Research)	Rejected
4-557	A	20	15	20	19	Is this figure from Bailis et al, 2005 or BP, 2004? (John Kessels, Energy Research Centre of the Netherlands)	Noted Check the reference.
4-558	A	20	15	0	0	"correlated with" (Heleen de Coninck, Energy research Centre of the Netherlands)	Accepted
4-559	A	20	15	20	16	There is text '…level of development is correlated to the degree of modern energy	Taken into account.

						services consumed in each country (Figure 4.2.6)'. However, the Figure shows only energy consumption (toe/capita); colors for each range of energy consumption level. The level of development can be shown by bars for each color. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	Possibilities of adding these bars will be sought.
4-560	A	20	15	0	0	Should read "indicate that … is LOOSELY correlated WITH the …" [there is often a factor of 2-3 difference in per capita energy use at any given degree of development] (Danny Harvey, University of Toronto)	Accepted
4-561	A	20	15	20	16	This sentence does not reflect the truth. Who can believe that Dutch, German, French people are far behind North American people and behind Russian people, as far as well-being and level of development are concerned ? A correct sentence would be :"In developing countries, up to a certain level, well-being and level of development is correlated to the degree of modern energy services consumed in each country" (Government of France)	Accepted
4-562	A	20	18	0	0	Figure 4.2.6. It is not possible to see the message of line 15 directly in the figure, but I guess you can use a reasonable knowledge of the GNP/capita of the world's countries to interpret it correctly. Would it be more powerful to put the two world maps side by side, i.e. the energy consumption and the GNP per capita? (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Taken into account. Your comment is good suggestion. Alternatively, the second data set could be displayed by bar/column diagrams.
4-563	A	20	18	0	0	Figure 4.2.6. The colours displayed in this Figure require adjustment. In the current display it is difficult to distinguish between categories in the map, especially between "4.5-6" and ">6". (Government of Japan)	Taken into account
4-564	A	20	19	0	0	Figure 4.2.6: The figures are on an annual basis, aren' they? If so please write 'Global annual energy …' (Manfred Treber, Germanwatch)	Taken into account
4-565	A	20	20	23	20	Lack of energy…this sentence perhaps would be better if instead of would not be met it could be changed will be difficult to be met. (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-566	A	20	20	20	24	Access to energy includes income generation hence it is difficult to provide energy and not income generation projects because then the energy remains in-accessible or un-affordable. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Taken into account

4-567	A	20	24	20	24	IEA figures are different (Ajay Guha, Asian Development Bank)	Taken into account Reference should be checked.
4-568	A	20	25	0	0	Replace "exceeded based on the historic" with "enhanced relative to". The sentence currently doesn't read well. (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted
4-569	A	20	25	0	0	Should read “Efforts will need to greatly exceed the historical rate of electricity ….” (Danny Harvey, University of Toronto)	Accepted
4-570	A	20	25	0	0	“Efforts will need to be greatly exceeded based on…vs. accelerated” U.S. Government (Government of U.S. Department of State)	Noted
4-571	A	20	26	0	0	Should read “ and 30 million per annum in the 1990s, at current rates of end-use efficiency”. (Danny Harvey, University of Toronto)	Accepted
4-572	A	20	29	20	29	To add: "…that employ both, renewable and non-renewable, …." (José Somoza, National Institute of Economic Research)	Noted Preference needs to be given to the use of renewable energy sources and nuclear energy.
4-573	A	20	29	21	2	Consider deleting sentence altogether because time frame is beyond this report. Otherwise, suggest replacing “renewable energy” with “non-GHG emitting energy sources” to avoid being policy proscriptive for renewables. Also suggest replacing “last indefinitely” with “last practically indefinitely.” U.S. Government (Government of U.S. Department of State)	Accepted
4-574	A	21	1	0	0	This is only valid if renewables are used sustainably - we know numerous examples where the use of renewables is limited in time by bad management practises. '… in the long term because these sources when used sustainably will last indefinitely …' (Manfred Treber, Germanwatch)	Noted
4-575	A	21	1	21	2	The definition used for sustainable development ("these sources will last indefinitely by human civilisation scales" is not a very common one. Better remove the whole sentence or replace by something more balanced, such as "Modern renewable energy and energy efficiency technologies can contribute to sustainable development." (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted
4-576	A	21	4	21	7	Shouldn't ecological implications also include emissions from combustion/electricity generation? (Also water and other effects of generation.)	Taken into account Ecological implications are not restricted to

						(Joanna Lewis, Pew Center on Global Climate Change)	those mentioned.
4-577	A	21	4	21	4	add 'gas" together with oil in the list "oil and gas extraction", "oil and gas transport" (DELLERO Nicole, AREVA)	Accepted
4-578	A	21	4	21	4	add 'gas" together with oil in the list "oil and gas extraction", "oil and gas transport" (DELLERO Nicole, AREVA)	Accepted
4-579	A	21	4	21	7	Does "ecological" not include air pollution? The paragraph seems too focused on land issues when nothing about other environmental or health concerns are addressed under the sustainability section. I would agree that renewables may have only a minor impact on improving land or water resources, but they have a huge impact on health and air issues which you have not addressed under sustainability (and I would argue that it should be addressed since it is a "quality of life" issue). At least refer to the sections on air and health. (Katherine Casey Delhotal, Research Trinagle Institute)	Taken into account
4-580	A	21	4	21	7	Mention biomass here - also has ecological implications. U.S. Government (Government of U.S. Department of State)	Noted
4-581	A	21	5	21	7	Include water impacts, competition with food crops, biodiversity impacts (Christine Copley, World Coal Institute)	Noted
4-582	A	21	9	72	0	The Section Primary energy resource potentials, supply chain, and conversion technologies is a very interesting section that enables us to see the available energy resources, the different existing technologies and their possibility for the reduction of the greenhouse effect. However, this very long section should have been very short and concise. Many developments should have only been references since even you had mentioned it at the beginning of this section that the techniques are developed elsewhere Meanwhile, the interesting points of this section could have been done again at the end of this section in the form of a recapitulative table that is more easier to read and which could enable to make a quick comparison of the different energy types with the state of availability of the resource, the state of the maturity of the techniques associated with them, the cost per Kwh produced if it is electricity from different techniques and finally the co-efficiency of the emissions per kwh. For instance, include the costs per kwh produced in the table 4.4.3 of page 82, to make it more interesting. (NOGOYE THIAM, ENDA- TM)	Rejected The discussion needs to be sufficiently detailed. Co-measurability of availability and maturity of energy sources would be problematic
4-583	A	21	12	0	0	I don't agree that wind energy has developed little since the TAR. The largest turbines, for example, have grown from 2 MW in capacity to 6 MW, and costs have	Taken into account "a little" instead of "little" is better.

						fallen substantially. Furthermore, there has been significant work in the analysis of baseload wind energy systems, and major new offshore windfarm construction. (Danny Harvey, University of Toronto)	

Comments on section 4.3.1.1-4.3.1.2 Bob+Clive

4-583	A	21	12	0	0	I don't agree that wind energy has developed little since the TAR. The largest turbines, for example, have grown from 2 MW in capacity to 6 MW, and costs have fallen substantially. Furthermore, there has been significant work in the analysis of baseload wind energy systems, and major new offshore windfarm construction. (Danny Harvey, University of Toronto)	
4-584	A	21	23	21	23	Comments related to the cost section of this chapter (starting on page 76), below, raise the matter of taking into account the lower risks attached to energy sources, such as renewable energy, which do not have the price volatility associated with fossil fuels, thus mitigating their up front costs (referencing Dr Shimon Awerbuch). It would be useful to add a short sentence here that the cost ranges in Table 4.3.1 do not take into account such wider economic factors. Clarifying how transmission and distribution costs are dealt is also relevant, as this comes up during the chapter later on. (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	
4-585	A	22	1	23	0	Table 4.3.1 Several parameters are unclear and are not sourced. a) Estimated available resource: This column compares the overall availability of fossil fuels with the annual available resource of renewables – but what is the limiting factor for? e.g. sunlight. A clear definition for the latter is missing. With the assumption that the current installed capacity is the limiting factor, is a future growth rate included? If yes, what growth rates and until when? Suggestion: Either delete column or add clear definitions and incorporate a timeline. b) Cost when located on a good site The ranges of costs for renewables is very broad. This does not represent the true costs e.g. PV will not cost more than 45c/kWh (= grid connected system in Germany). 160 c/kWh is almost four times too high and should be amended. (Sven Teske, Greenpeace International)	Accept line 1 a)reject – we use per annum b)reject – our refernves are sound
4-586	A	22	1	23	1	Table 4.3.1 uses old data. For renewable sources, please use the REN21 Global Status Report 2006 update (http://www.ren21.net/globalstatusreport/issueGroup.asp), and I have attached our	Consider, will look at references Numbers not meaningless

						two latest status reports with conducted with the Solar PV and Wind industries, respectively (ref). Also, suggest Energy Technology Perspectives (IEA 2006a) for the latest up to date analysis on the broad range of technologies. Furthermore, the use combination of EJ/yr for primary energy and TWh for electricity is confusing and misleading as noted in Note D. Suggest separating the Fossil energy into its various uses (heat, power) etc., and then use an a unit of measurement appropriate to the technology and its end use. EJ of hydro and/or wind is a meaningless and fundamentally misleading number, as is the EJ output of a nuclear power plant. Finally, it seems to me that solar thermal hot water and heating is completely missing from the chart. Global data are available in the REN 21 report listed above, and are outlined on p 53 (lines 28-48) and p 54 (lines 1-11) of this draft. (Steve Sawyer, Greenpeace International)	
4-587	A	22	1	23	0	Table 4.3.1 Fifth, as I stated in the last review, I would suggest dropping the column "Comments on environmental impacts" as there is really not enough space to adequately address this issue. Only mentioning the carbon emissions from coal, gas and oil and spent fuel disposition for nuclear barely scratches the surface on the enviromental impacts of these resources. These resource have tremendous air, water, land-use, and biodiversity impacts across the fuel cycle that should be addressed in more detail in the body of the report. Geothermal is also not really resource limited in relative comparison to other resources but large scale electricity generation from geothermal is certainly limited to certain areas of the world. (Steve Clemmer, Union of Concerned Scientists)	Reject – this is a C mitigation report
4-588	A	22	1	23	0	Table 4.3.1. While some improvements were made to this table since the last review, I still have several problems. First, do the cost ranges represent "current" costs at good sites and do they consider projected cost reductions due to additional learning, mass production, and R&D? Please clarify in the notes. I think it would be useful to have two columns, one showing the current cost range and one showing the future cost range. Second, the low end of the cost range for nuclear (3c/kWh) is not realistic. Data from the US Energy Information Administration show costs for a new advanced nuclear plant at ~6 c/kWh. Historical data has shown that the nuclear industry has consistently underestimated the cost of new plants. Third, none of the cost ranges for coal, gas, or oil include future CO2 costs, either through paying allowances, taxes, or by implementing CCS. For example, a CO2 price of $20/ton would cost ~2 c/kWh for a new supercritical pulverized coal plant. I would suggest clarifying this in the notes or adding it to the table. Fourth,	Noted

						the cost ranges for renewables are so large, it's not clear what they represent. It would be more meaningful to have a supply curve or some indication of how much of each resource is available at a given price. (Steve Clemmer, Union of Concerned Scientists)	
4-589	A	22	1	23	0	Table 4.3.1. While some improvements were made to this table since the last review, I still have several problems. First, do the cost ranges represent "current" costs at good sites and do they consider projected cost reductions due to additional learning, mass production, and R&D? Please clarify in the notes. I think it would be useful to have two columns, one showing the current cost range and one showing the future cost range. Second, the low end of the cost range for nuclear (3c/kWh) is not realistic. Data from the US Energy Information Administration show costs for a new advanced nuclear plant at ~6 c/kWh. Historical data has shown that the nuclear industry has consistently underestimated the cost of new plants. Third, none of the cost ranges for coal, gas, or oil include future CO2 costs, either through paying allowances, taxes, or by implementing CCS. For example, a CO2 price of $20/ton would cost ~2 c/kWh for a new supercritical pulverized coal plant. I would suggest clarifying this in the notes or adding it to the table. Fourth, the cost ranges for renewables are so large, it's not clear what they represent. It would be more meaningful to have a supply curve or some indication of how much of each resource is available at a given price. (Steve Clemmer, Union of Concerned Scientists)	Se 4-588
4-590	A	22	1	23	0	Table 4.3.1 Fifth, as I stated in the last review, I would suggest dropping the column "Comments on environmental impacts" as there is really not enough space to adequately address this issue. Only mentioning the carbon emissions from coal, gas and oil and spent fuel disposition for nuclear barely scratches the surface on the enviromental impacts of these resources. These resource have tremendous air, water, land-use, and biodiversity impacts across the fuel cycle that should be addressed in more detail in the body of the report. Geothermal is also not really resource limited in relative comparison to other resources but large scale electricity generation from geothermal is certainly limited to certain areas of the world. (Steve Clemmer, Union of Concerned Scientists)	See 4-587
4-591	A	22	1	22	0	Table 4.3.1: the table does not account for concentrating solar power, which has a potential equivalent if not greater to that of PV due to already better conversion rates. The estimate given for the potential of solar thermal is absolutely insane. The supply is overabundant (the Earth's surface receives from the sun every hour an	Reject – no reference given

						amount of energy about equal to current global consumption over a year), and the demand is considerable, as about half our useful energy requirements is for heat. (Cédric PHILIBERT, International Energy Agency)	
4-592	A	22	1	23	1	The question marks (?) and the blank cells in the Table 4.3.1 may be replaced with the factual position whether "Not available"/"Not applicable" or what ever more suitable phrase. Foot notes a, b, c, d may also be shifted to the bottom of the Table instead of being before the Table. (Muhammad Latif, Applied Systems Analysis Group)	Accept
4-593	A	22	1	0	0	Table 4.3.1.fails to clarify what is meant by "available" (as in heading Estimates available resource). The 16,000 EJ for conventional oil is about the US Geological Survey's "medium" estimate. OK as such ,although the USGS range is about 11,000 to 22,250 EJ. Worse is the unconventional oil figure at 35,000 EJ, wheras only some 6,300 EJ are estimated as recoverable. (Michael Jefferson, World Renewable Energy Network & Congresses)	Noted – will check
4-594	A	22	1	23	0	The costs shown in Table 4.3.1 are likely to receive scrutiny and be a source of debate. The Table 4.3.1 footnotes should be expanded to explain the top-level definitions and important assumptions that are the basis for costs –particularly if the basis for the unit costs are different or more narrow than the basis for the available resource projection. As an example, the footnotes should explained whether the costs "when located in a good site" are levelized costs versus marginal costs; whether they have been measured at the busbar or in the retail market. As a different example, it would be helpful to state which wind resource zones are assumed when calculating unit cost and whether these are both on-shore or off-shore, and whether these wind resource zones are the same as those that are assumed when estimating the available wind energy resource. The assumed values for capacity factors (single values or ranges) and assumptions about intermittency should be noted for the energy costs of those resources that are intermittent and variable by nature, or currently have an immature technology base. U.S. Government (Government of U.S. Department of State)	Noted – will move to Table 4.4.2
4-595	A	22	1	23	0	Table 4.3.1 is misleading and needs careful scrutiny with clarification of assumptions. U.S. Government (Government of U.S. Department of State)	Accepted
4-596	A	22	22	11	11	There is no definition of "conventional fuel" / "unconventional fuel" in the glossary!! to be added!	Accepted

						(Government of Germany)	
4-597	A	23	0	23	0	Table 4.3.1: The market potential of solar thermal resources is at least as high as of solar-PV. (,)	Rejected – no reference given
4-598	A	23	0	23	0	Table 4.3.1: estimated resources are questionnable, in particular for nuclear fusion which is unknown by anyone. The estimated costs are questionnable as well: the overlap of the brackets for conventional and unconventional oil is strange, the cost of wind kWh is quoted as being the the same as the nuclear kWh, while Electricité de France must pay a much higher price to the wind energy producers ! (Government of France)	Noted
4-20	B	23	0	23	0	Row "Solar PV": 160 ct/kWh is very high, compare with 9 Ct on chap. 3 p 94 (which is too low) (Government of Germany)	TSU – we gave a referenece
4-599	A	23	1	0	0	Table 4.3.1. This also needs a footnote or a change to reflect the dramatic change that a move to fast reactor technology could achieve. This could expand the energy available by at least a factor of 30 (NEA/IAEA Red Book 2005), i.e. to 222,000 EJ. This is much more available energy than any of the other non-renewable sources, with the exception of fusion, where the technology is a long way from practical realization, though with enormous promise if it can be made to work. Fast reactor technology is a reasonably well developed; fast reactors have been built and are operating successfully albeit not really commercially, but have not been widely deployed. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Accepted
4-600	A	23	1	23	0	Table 4.3.1. Add a row on Concentrating Solar Power: Estimated resource: A detailed Study on the resource in the Mediterranean Area (www.dlr.de/tt/med-csp. Table 3.1) estimates the economic resources potential as > 600000TWh electric energy. Assuming a conversion ratio to heat a factor 3 this results in more than 8000 EJ/year only for the Mediterranean area. The worlds potential is probably 10 times as high. Rate of use in 2003 is 556 GWh (IEA Renewables Information) in SEGS plants which equals 0,005 EJ at generation cost between 12 and 18 UScents/kWh (http://www.energy.ca.gov/2005publications/CEC-500-2005-175/CEC-500-2005-175.PDF, figure 59) (Robert Pitz-Paal, German Aerospace Centre (DLR))	Accepted
4-601	A	23	1	0	0	The row for fusion in Table 4.3.1 is in part seriously outdated and incorrect. A corrected version would read Specific type of energy source: Fusion / Estimated	Accepted

						available energy resource (EJ): 300,000 (land) 5x10^9 (ocean) / Rate of use in 2003 (EJ/yr): 0 / Cost when located on a good site: 5 - 10¢/ kWh(e)* / Comments on environmental impacts: Small* / References: R. Keith Evans, "Lithium reserves and Resources", Energy, 3, 379-385 (1978) Footnote: *projected [The comments about cost and waste disposal issues are completely out of date and incorrect. A range of conceptual fusion power plant designs project to 5–10¢/ kWe. These projected designs result in low-level waste that only calls for shallow-land burial, not geologic storage. These could be quoted with the footnote *"projected." An appropriate website reference would be www-ferp.ucsd.edu/ARIES/] (Robert Goldston, Princeton Plasma Physics Laboratory)	
4-602	A	23	1	0	0	The nuclear fusion slice of Table 4.3.1 needs revising. The waste disposal issue with fusion is not "unknown" and has been extensively studied. For example the 2005 Fusion Power Plant Conceptual (PPCS) study done under EFDA (European Fusion Development Agreement) showed that current fusion reactor designs are feasible that involve no deep geological disposal of fusion waste materials which will be primarily be reactor components. The same study projected fusion electricity costs as 0.06 to 0.09 Eurocents/kWh. (David Jackson, McMaster University)	Accepted
4-603	A	23	1	0	0	Table 4.3.1: I see that the potential of Solar thermal is quite limited and its cost is quite high (12 - 34 c/kWh), I don't see any decrease of the cost from economies of scale although its economic application in Europe has just begun. Is there only one single source on solar thermal? If you look at page 52, lines 17 and 18 in chapter 4 you get another impression of the potential of solar thermal power plants. (Manfred Treber, Germanwatch)	Accepted
4-604	A	23	1	23	0	Coal Mine Methane perhaps a better specific type of energy source than Coal Bed Methane (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-605	A	23	1	23	0	This table is too confusing (Ajay Guha, Asian Development Bank)	Accepted
4-606	A	23	1	23	0	Table 4.3.1 Please add reference to Chapter 10 for energy from waste since this is not included in this table. (,)	Accepted
4-607	A	23	1	23	1	Table 4.3.1: The numbers for "Estimated available resource" (EJ/a) for Renewables seem to be arbitrary and far too low. At other passages in the Report, e.g. c 4, p 52, line 17, it is noted that the technical potential is a multiple of the global demand in	Rejected – no refernece but will add refernece

						2030. Hence, the market potential is only a function of experience curves and political priorities. (,)	
4-608	A	23	1	23	0	Table 4.3.1. Rows 16&17, Column 6: The cost of electricity 12¢kWh is high even for Uranium resource category of $130/kg . This cost is 10¢kWh in in year 2005 (please see Table 4.4.2 at page 80). Please also add a footnote for year of USD.i.e USD of year 2003. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	Rejected – no reference but will adjust table
4-609	A	23	1	23	0	Table 4.3.1. Rows 16&17, Column 3: The Uranium resource @ $130/kg are not for Uranium 235 only. These resources are for Uranium metal (containing 0.7% U235 and 99.3% U238). Though U235 is being used for electricity generation, the phrase @ $130/kg for U 235 is misleading. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	See 4-608
4-610	A	23	1	23	0	Table 4.3.1. Row 4, Column 7 (Environmental impacts) . Along with carbon emissions, coal, oil and gas have Nox emissions. There is need to mention these emissions. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	Accept – footnote to be added in report
4-611	A	23	1	23	0	Table 4.3.1. Row 26, Column 7 (Environmental impacts) . The phrase 'Resource limited ?' is misleading. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	Accepted
4-612	A	23	1	23	0	Table 4.3.1. Column 5 ' Share (%)'. Please change it into 'Share in primary energy supply in year 2003 (%)' (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	Reject
4-613	A	23	1	23	1	Table 4,3,1: delate 1-12 c$/kWh for nuclear. keep only 3-7 c$/kWh. Quote the new IEA WEO 2006 nuclear chapter to be issued. Difficulty to understand what the share in % means in the table. (DELLERO Nicole, AREVA)	Reject – have already considered the referenced ranges
4-614	A	23	1	23	1	Table 4,3,1: delate 1-12 c$/kWh for nuclear. keep only 3-7 c$/kWh. Quote the new IEA WEO 2006 nuclear chapter to be issued. Difficulty to understand what the share in % means in the table. (DELLERO Nicole, AREVA)	See 4-613
4-615	A	23	1	0	0	Table4.3.1 The figure shown for available resource of fusion energy, 5,000,000,000 EJ, seems quite rough and uncertain. The calculational assumptions should be briefly given in	See 4-601

						Section 4.3.2.5 "Nuclear Fusion. What's the constraints of this amount? Lithium or deuterium? Instead of using this rough value, it might be better to just state 'inexhaustible'. This Evans's reference is old. (Ryota OMORI, Japan Science and Technology Agency)	
4-616	A	23	1	23	1	Table 4.3.1. Please improve table; add ranges, add Progress Ratio range for technological learning,. Are the cost ranges indeed all ranges at good sites? For renewables it doesn't seem to be (e.g. compare Table 4.3.1 with figure 3.5 for wind energy it seems that the highest range is at less good sites). (Government of European Community / European Commission)	Accepted
4-617	A	23	1	23	1	Please add the MIT study for nuclear, they come up with 7 c/kWh as AVERAGE not as highest! So: is the range for nuclear correct? and not too optimistic? What future costs can be expected? What type of costs are actually included (in- or excluding hidden subsidies)? (Government of European Community / European Commission)	Reject – we use prices today, MIT future prices
4-618	A	23	1	23	0	The value for the Fusion resource base shown in the table is not explained or referred to in the text description of nuclear fusion. Because the number is so much larger than all the other resource numbers in the table, the report should explain the assumptions or methodology that were used to produce the Fusion resource estimate. U.S. Government (Government of U.S. Department of State)	See 4-601
4-619	A	23	1	23	0	The use of the term "Fusion" as an energy source category is not consistent with the methodology used to label other categories. The energy resource in Fusion is deuterium and tritium; the tritium is bred from lithium (and more specifically from the lithium-7 isotope.) Consistent with other suggestion that has been made it is proposed that the nuclear category on this table be divided into Fission and Fusion. Fission should be shown as having a uranium and thorium energy resource, and Fusion as having a "deuterium, tritium" resource or alternatively, as "heavy hydrogen isotopes". U.S. Government (Government of U.S. Department of State)	Reject see text
4-620	A	23	1	23	0	The row for fusion in Table 4.3.1 is in part seriously outdated and incorrect. A corrected version would read Specific type of energy source: Fusion / Estimated available energy resource (EJ): 300,000 (land) 5x10^9 (ocean) / Rate of use in 2003 (EJ/yr): 0 / Cost when located on a good site: 5 - 10¢/ kWh(e)* / Comments on environmental impacts: Small* / References: R. Keith Evans, "Lithium reserves and Resources", Energy, 3, 379-385 (1978) Footnote: *projected [The comments	See 4-601

						about cost and waste disposal issues are completely out of date and incorrect. A range of conceptual fusion power plant designs project to 5–10¢/ kWe. These projected designs result in low-level waste that only calls for shallow-land burial, not geologic storage. These could be quoted with the footnote *"projected." An appropriate website reference would be www-ferp.ucsd.edu/ARIES/] U.S. Government (Government of U.S. Department of State)	
4-621	A	23	1	23	0	The lumping together of U-238 and Thorium into one resource category is confusing and unhelpful. Uranium-238 is widely used commercially in LWRs (low enriched uranium and mixed oxide Pu/U fuels) and in CANDU reactors systems (as natural uranium). Thorium is not currently a commercial energy fuel and the consideration of its potential as a fuel would be made more accessible by separating it from Uranium-238 in this table and in all discussions within the report. U.S. Government (Government of U.S. Department of State)	Accept
4-622	A	23	1	23	0	Table: "Share (%)" -- unclear what this means. Under Renewable electricity heat and biofuels, for biomass, about 46 is used under rate of use in 2003. Does this include traditional biomass? Also, 2 columns over under comments on environmental impacts, it says "monocultures." An explanation of what is meant here would be helpful. U.S. Government (Government of U.S. Department of State)	Accept – will clarify
4-623	A	23	1	23	0	Table 4.3.1. Why are two ranges shown for the cost of U235 fuel? U.S. Government (Government of U.S. Department of State)	Noted – 2 references used
4-624	A	23	1	23	0	Table 4.3.1 needs a better explanation of cost calculations and financial assumptions "Allocation of transmission costs and geospatial factors also significantly effect full life cycle costs" U.S. Government (Government of U.S. Department of State)	Accepted – move to table 4.4.2
4-625	A	23	1	23	0	On table 4.3.1, nuclear fission energy resources are subdivided into "U-235 fuel" and "U-238 and Thorium Fuel." There is no such thing as U-235 fuel. Conventional LWR fuel is 3-5% U-235 and the remainder U-238. Both isotopes are burned in an LWR (U-238 by a nuclear capture and transmutation to Pu-239 followed by another neutron capture and subsequent.fission event). At the end of an a typical LWR fuel irradiation, there is more Plutonium in the nuclear fuel than U-235 indicating that more than half of the fission energy was coming plutonium,	Accept

						i.e., from "U-238" breeding. So referring to LWR fuel as U-235 fuel is inaccurate. CANDU reactors use natural uranium at 0.711% and also rely substantially on burning of U-238. A number of French reactors are burning commercial mixed oxide (MOX) uranium/plutonium fuel that burns both Pu-239 (previously bred from U-238), U-238 and U-235. Thus, the division of the uranium resource in table 4.3.1 into uranium isotopes does not have techncial meaning, and presents an inaccurate view of energy resources. The recommended format should be to list uranium as one nuclear fuel resource and thorium as another nuclear fuel resource. U.S. Government (Government of U.S. Department of State)	
4-626	A	23	1	23	0	In Table 4.3.1 the environmental impact comment "Waste disposal impacts unknown" should be aligned with the row labeled Thorium (or thorium and uranium-238), not with Fusion. It is believed that this comment refers to the unknown impacts from disposal of reprocessing plant wastes. U.S. Government (Government of U.S. Department of State)	Reject – misread the table
4-21	B	23	1	23	1	In Table 4.3.1 under "Biomass" monocultures and local transport are mentioned as environmental impacts. Monocultures is only relevant for crops, not for residues. Also, to keep the balance, numerous environmental impacts for fossils and nuclears should be added, such as impacts of mining, risk of nuclear accidents, impacts of oil transport, etc. (Government of Germany)	Accept – column dropped
4-627	A	23	11	0	0	In Table 4.3.1, ranges should be given for all of the estimated available resources, to reflect that considerable uncertainty that exists. For each renewable resource, a footnote should be added that gives the associated assumptions (such as land areas involved and efficiencies, where applicable). (Danny Harvey, University of Toronto)	Noted – see footnotes
4-628	A	23	16	23	31	According to the US Department of Energy, The incremental energy cost in some Eastern US states of concentrating solar power (which is not mentioned in the chapter) required of ratepayers if: 500 MW in CA - 5 cents/month 200 MW in NM - 69 cents/month 150 MW in AZ - 35 cents/month 150 MW in NV - 64 cents/month Source: Frank Wilkins Solar Thermal R&D Team Leader U.S. Department of Energy	Reject – no clear reference

						Washington, DC (Catherine Pearce, Friends of the Earth International)	
4-629	A	23	18	0	0	In Table 4.3.1, in the fusion row, the comment on cost is completely incorrect, presumably based on very old information. In the last decade and a half, many very detailed studies of conceptual fusion power plants have been performed, in Europe, USA and Japan. The well-established range of projections for cost of electricity is 5-10cents/kWh(e) [Refs. 1,2,3,4], and this is the appropriate range to enter in the 'Cost when located on a good site' column. These projections have been benchmarked against the well-authenticated (by industry) costs of the 500MW fusion device (ITER) which is beginning construction in France supported by a seven-government consortium. References: [1] D.J. Ward, I. Cook, Y. Lechon, R.Saez, "The Economic Viability of Fusion Power", Fusion Engineering and Design 75-79 (2005) 1221-1227. [2] D Maisonnier, I Cook, P Sardain, R Andreani, L Di Pace, R Forrest, L Giancarli, S Hermsmeyer, P Norajitra, N Taylor, D Ward, "A Conceptual Study of Commercial Fusion Power Plants: Final Report of the European Power Plant Conceptual Study". European Fusion Development Agreement (EFDA) Report EFDA-RP-RE-5.0, April 2005. [3] I. Cook, D. Maisonnier, N.P. Taylor, D.J. Ward, P. Sardain, L. Di Pace, L. Giancarli, S. Hermsmeyer, P. Norajitra and R. Forrest, "European Fusion Power Plant Studies", Fusion Science and Technology 47, 384, April 2005. [4] F. Najmabadi et al., 'ARIES-AT: an Advanced Tokamak, Advanced Technology, Fusion Power Plant', 18th IAEA Fusion Energy Conference, Sorrento, Oct. 2000. (Ian Cook, United Kingdom Atomic Energy Authority)	Reject – table is today's costs
4-630	A	23	18	0	0	In Table 4.3.1, in the fusion row, the comment on environmental impacts is completely incorrect, presumably based on very old information. In the last decade and a half, many very detailed studies of conceptual fusion power plants have been performed, in Europe, USA and Japan. These studies show very clearly and with very high confidence that fusion waste does not require geological storage and that the worst possible accidents are very limited [Refs A,B,C]. Accordingly, the correct entry in the 'Comments on environmental impacts' column is 'Minor impacts only'. References: [A] D Maisonnier, I Cook, P Sardain, R Andreani, L Di Pace, R Forrest, L Giancarli, S Hermsmeyer, P Norajitra, N Taylor, D Ward, "A Conceptual Study of Commercial Fusion Power Plants: Final Report of the European Power Plant Conceptual Study". European Fusion Development Agreement (EFDA)	See 4-629

						Report EFDA-RP-RE-5.0, April 2005. [B] I. Cook, D. Maisonnier, N.P. Taylor, D.J. Ward, P. Sardain, L. Di Pace, L. Giancarli, S. Hermsmeyer, P. Norajitra and R. Forrest, "European Fusion Power Plant Studies", Fusion Science and Technology 47, 384, April 2005. [C] F. Najmabadi et al., 'ARIES-AT: an Advanced Tokamak, Advanced Technology, Fusion Power Plant', 18th IAEA Fusion Energy Conference, Sorrento, Oct. 2000. (,)	
4-631	A	23	25	23	25	The only comment on environmental impact is "monocultures" this clearly is not the most relevant impact. Sufficient excellent references exist to also mention CO2 efficiency, impact on biodiversity, depletion of soil organic matter to name a few. I would say do not present anything or make a more cridible list. (Wolter Elbersen, WUR, AFSG)	See 4-21
4-632	A	23	0	23	0	Table 4.3.1. contains an entry in column 7 for natural gas which states "cost @360/Mm3" under environmental impacts. What does this mean? Furthermore in this table: the lower ends of the costs (in column 6) for renewables small hydro, wind and biomass are very low and well below the lower end of the cost range for conventionally generated electricity. This may be the case for some very exceptionally good sites, however, since these renewables in general still receive subsidies, this lower end seems unlikely. If the lower values were true, the penetration rate of renewables would be better than observed today. (Walter Ruijgrok, EnergieNed)	Accepted – adjust table
4-633	A	23	0	0	0	There is a table on this page. Among other details, this table gives Estimated available resource in EJ. For uranium this is given as 7400 EJ and it is a good estimate. If one goes in for closed fuel cycle, U238 can be used to generate energy. Even if one assumes 3 cycles and a burn up of about 200,000 MWd/tonne for fast reactors, the energy that can be obtained from U238 has to be about 70 times the energy that can be obtained from U235 when used in once through mode. Electricity generated will be higher because of higher thermal efficiency of fast reactors. Therefore, the energy potential of U238 has to be at least 70x7400 that is 512,000. Similar amount can be produced from thorium and so the number 213,000 given for U238 and thorium is grossly underestimated. It may be changed to 'above 1,000,000'. We have done similar calculations for resources available in India and the details are available in the following paper: Grover R B and Chandra S (2006), "Scenario for growth of electricity in India", Energy Policy, 34(2006), 2834-2847.	Reject – we use iaea red book

						(Ravi B Grover, Department of Atomic Energy)	
4-634	A	23	0	0	0	Table 4.3.1. See my comment on Figure 4.3.2 on page 32. (Jan Willem Storm van Leeuwen, Ceedata Consultants)	Noted without comment
4-635	A	24	1	0	0	The state of Yugoslavia which is meant here does not exist any more. Therefore please write 'former Yugoslavia'. (Manfred Treber, Germanwatch)	Noted
4-636	A	24	4	0	0	The reduction in share of coal between 1971 and 2002 was important (from 26% to 23%), but smaller than oil (43% to 35%). I suggest you change the last part of the sentence to "…from oil and, to a lesser extent, coal." (Michael Taylor, International Energy Agency)	Accept
4-637	A	24	6	24	38	Section 4.3.1. "Fossil energy resources remain abundant...." And what about with The Hubbert's Theory of the "Pick". also well-known as "Zenith of the Petroleum", It is an influential theory about the rate of long term exhaustion of the petroleum, as well as of other fossil fuels. The debate is not centered on pick of for petroleum , but rather on the timing for this happen since it is evident that the petroleum is a finite and not renewable resource in short scales of time for that in a moment or another you will arrive to the extraction limit. Based on current data of production, the Association for the Study of the Pick of the Petroleum and the Gas (ASPO), considers that the pick of the petroleum will happen in 2007. The theory of Hubbert has been applied for other fossil resources as the natural gas. The Association for the Study of the Pick of the Petroleum and the Gas (ASPO) locates the pick of the natural gas between the 2010 and the 2020. (José Somoza, National Institute of Economic Research)	Reject – no reference and the timing is not the relevant issue for the long term.
4-638	A	24	6	68	19	Section 4.3.1 Fossil Fuels - There should be a consistent approach to discussing environmental risks in this section. There is an arbitrary approach at present e.g. hydro & unconventional oil have environmental risk tag lines, while coal mining environmental impact is not mentioned. U.S. Government (Government of U.S. Department of State)	Accepted
4-639	A	24	8	0	0	For reasons of constraints on recoverable conventional oil resources, fossil energy resources do not "remain abundant"; nor do unconventional oil resources; nor, in the longer run (by 2050) does natural gas.The total proven, probable reserves AND POSSIBLE RESOURCES as estimated by numerous authorities (max. about 4 trillion barrels) are not enough to last for more than four decades - probably a much shorter time given a broader consensus around resource figures closer to 2 trillion barrels - so current wording is misleadingly over-optimistic.	Reject – no references

						(Michael Jefferson, World Renewable Energy Network & Congresses)	
4-640	A	24	9	24	10	When the reserves run out is not relevant as far as socio-economic impacts are concerned. Rather, it is when the rate of extraction (so called "production") will peak, as that is when prices will increase sharply and will become very volatile. (Danny Harvey, University of Toronto)	Noted but not relevant
4-641	A	24	11	24	13	If resources remain abundant in general, one should precise that period of the cheap oil and gas is finished. While approaching the "peak" for oil and gas, prices will increase further, and increase even more in the following period of declining reserves. This will have a strong effect on energy policies, and should be taken into account in all scenarii. This should be taken as an opportunity for mitigation policies. While chaging the energy supply, incentives should help decision makers to get read of fossil fuels and choose renewable energy sources. The worst case being a scenario of maitained fossil energy production from coal and unconventional fuels with high emissions due to low cost technologies. (VARET jacques, French Geological Survey)	Noted – no references
4-642	A	24	13	24	17	Here (page 24, lines 13-17) and in coming sections of the chapter, World energy data is discussed for the years 2002. Figure 4.2.1 (page 12 of Chapter 4) shows global 2003 energy flows from primary energy through carrier to end-use. The figure also shows Carbon dioxide emission for the year 2003. So, data for year 2003 may be given (instead of data for year 2002 as given here on page 24, lines 13-14 and page 39 line 22) if data is not available for year 2004 or 2005. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	Accept
4-643	A	24	13	0	0	Use data for 2004 from IEA or BP, 2002 is a little out of date. Please contact me if you don't have access to the latest IEA statistics or see our website (www.iea.org). (Michael Taylor, International Energy Agency)	Accept
4-644	A	24	13	24	13	Replace "Oil..." with "Excluding traditional biomass, oil...". Percentages are otherwise inconsistent. (Brian Ricketts, International Energy Agency)	Accept
4-645	A	24	13	24	13	"Fossil fuels……demand in 2002 (IEA, 2005)". What is the correct reference for IEA, 2005 (Government of India)	Accept
4-646	A	24	14	24	15	Replace "If only modern energy supplies were considered (by excluding traditional biomass), the fossil fuel share approaches 90% and ..." with "The fossil fuel share of modern energy supplies approaches 90% and ...". (Brian Ricketts, International Energy Agency)	Accept

4-647	A	24	14	24	16	"If only modern energy……..next 20-30 years". the general idea is as such clear but the reporting is very much all over the place; the references are getting mix from quote to quote and breaking the flow of text. The text needs to improve for clarity. (Government of India)	Accept
4-648	A	24	16	24	16	…and there is every reason to expect it to grow over the next 20-30 years'. Suggest that this be reworded to say that 'and in the absence of policies to promote low carbon energy sources and in the absence of effective measures to mitigate climate change it is expected to grow over the next 20-30 years'. This could be modified even further pending publication of the IEA WEO 2006, where the fundamental economic and political unsustainability, as well as the environmental unsustainability of this prospect is highlighted even further. (Steve Sawyer, Greenpeace International)	Accept
4-22	B	24	17	24	17	Replace "year to 2004" with "2003". (Government of Australia)	Accept
4-649	A	24	18	24	22	The over-optimistic statements here about oil consumption, its continued growth, domination until at least 2030, etc. need to be severely qualified by the impending constraints resulting from recoverable conventional oil resources being limited. (Michael Jefferson, World Renewable Energy Network & Congresses)	Reject – no references
4-650	A	24	19	24	20	Replace "Oil and gas..." with "Oil, coal and gas...". Accuracy calls for this. (Brian Ricketts, International Energy Agency)	Accept
4-651	A	24	28	24	31	Suggest rewording, "Fossil fuels have large economic advantages that other technologies may not be able to overcome, including annual subsidies from governments of between 200 and 250 billion USD per year (van Beers, Cees, & de Moor, André, Public Subsidies and Policy Failures: How Subsidies Distort the Natural Environment, Equityand Trade, and how to Reform them, Edward Elgar Publishers, Cheltenham UK, November 2001; and UNDP, Johansson et al., UNDP's World Energy Assessement - 2004 update (http://www.undp.org/energy/weaover2004.htm), as well as the lack of a fully implemented global system to account for the costs of CO2 emissions as well as other external costs. Concern over energy security, economic development, local pollution concerns and climate change, combined with the recent trend for fossil fuel prices to increase, as well as industrial learning in renewable energy technologies has resulted in relatively larger growth rates for renewable energy technologies. Combining a redirection of government subsidies as well as the	Noted

						moves towards a global climate mitigation regime could increase this trend very rapidly." On the general subject of subsidies, there is a brief discussion on pages 94-95 of this draft but the important information contained there is not referenced at the appropriate places throughout the report - or rather, the fact that renewables 'need support' is often mentioned, but rarely the other 97-98% of energy subsidies which support 'conventional' energy sources. Some balance please, gentlemen. (Steve Sawyer, Greenpeace International)	
4-652	A	24	28	24	32	Tell the story correctely : advantages of fossil are not economic because they have high volatility and an increasing price trend. The market will decide with the most competitive options which will be not necessarily fossil fuels. Th pattern will be country specific and will depend on government policy. (DELLERO Nicole, AREVA)	Noted
4-653	A	24	28	24	32	Tell the story correctely : advantages of fossil are not economic because they have high volatility and an increasing price trend. The market will decide with the most competitive options which will be not necessarily fossil fuels. Th pattern will be country specific and will depend on government policy. (DELLERO Nicole, AREVA)	See 4-652
4-654	A	24	28	24	28	Delete "potential". (Brian Ricketts, International Energy Agency)	accept
4-655	A	24	28	24	29	“in most countries, under current pricing schemes; e.g., non-CO2 inclusions.” U.S. Government (Government of U.S. Department of State)	accept
4-23	B	24	29	24	31	Wording suggests that fossil fuel prices are increasing because of "continued improvements". Suggest rewording of the sentence to something like "…, although there has been a recent trend for fossil fuel prices to increase while the price of renewables has decreased due to continued productivity improvements." (Government of Australia)	Accept with thanks
4-24	B	24	30	24	30	Recommend a short reason is given for why fossil fuel prices have tended to increase. (Government of Australia)	Noted – no short answer
4-656	A	24	31	24	34	The paragraph states that all fossil fuel options will plausibly continue to be used if matters are left solely to the market to decide choice of energy conversion technologies. It further states that if GHGs are to be reduced significantly, either current uses of fossil energy will have to shift non-carbon sources or technologies will have to be adopted that capture and store CO2 emissions. The statement that	Noted – say ‘shift towards’

						fossil fuels will continue if left solely to the market seems to be supporting increased government intervention. If so, the section may want to state that government intervention should not lead to them picking winners and losers. In terms of the second statement on significantly reducing GHGs, it should be empahzied that all fuel types - conventional, non-conventional and emerging - should be utilized instead of either completly shifting to non-carbon sources or utilizing CO2 capture. (Eli Turk, Canadian Electricity Association (CEA))	
4-657	A	24	34	24	34	"or technologies will have to be adopted" should be revised to state "and/or technologies will have to be adopted". It does not have to be one or the other; both can have a place in the solution. U.S. Government (Government of U.S. Department of State)	accept
4-658	A	24	37	24	37	Add to the end of this sentence ", and deployment of existing low or zero carbon technology options, at larger scale". (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	accept
4-659	A	24	39	24	39	Have a separate sub heading for Peat it is a minor energy supply source and should be separated out from coal (John Kessels, Energy Research Centre of the Netherlands)	Reject – can't place elsewhere
4-660	A	24	39	26	0	See my previous attachment on coal, given the key role that coal technologies will play in future mitigation potential and activities a page and a bit on coal is extremely short compared to some other sections on energy supply technologies and resources (John Kessels, Energy Research Centre of the Netherlands)	Noted
4-661	A	24	39	26	0	Section 4.3.1.1 leaves out several important factors. The point made rather briefly on p. 24, line 32: "If GHGs are to be reduced significantly, either current uses of fossil energy will have to shift to non-carbon sources, or technologies will have to be adopted that capture and store the CO2 emissions," should be expanded and emphasized more strongly in this discussion. I would also suggest adding information about the potential negative fuel cycle environmental and public health impacts of increasing or maintaining our reliance on coal, even if used in advance technologies. I would also suggest including a discussion about the new coal plants being built in China, the US and India and make some estimate of the CO2 emissions they represent. (Steve Clemmer, Union of Concerned Scientists)	Noted – no reference
4-662	A	24	46	0	0	The table 4.3.1 has 100000 EJ total resource, but here you add 100000 to the	Noted – see footnote and change numbers to

						33000 EJ proven plus probable reserves, which is correct? (Michael Taylor, International Energy Agency)	match
4-663	A	24	0	26	0	Section 4.3.1.1 leaves out several important factors. The point made rather briefly on p. 24, line 32: "If GHGs are to be reduced significantly, either current uses of fossil energy will have to shift to non-carbon sources, or technologies will have to be adopted that capture and store the CO2 emissions," should be expanded and emphasized more strongly in this discussion. I would also suggest adding information about the potential negative fuel cycle environmental and public health impacts of increasing or maintaining our reliance on coal, even if used in advance technologies. I would also suggest including a discussion about the new coal plants being built in China, the US and India and make some estimate of the CO2 emissions they represent. (Steve Clemmer, Union of Concerned Scientists)	See 4-661
4-664	A	25	0	26	0	It is claimed that the thermal efficiency of coal-based power plants has improved from 35% (conventional steam cycles) to over 55% in "best design" IGCCs. At the same time advanced design NGCCs under development are claimed to approach 60% conversion efficiency. This implies a difference less than 5% points between "best design" IGCCs and NGCCs under development. Bearing in mind that gasification implies significant energy penalties, the difference is surprisingly small. In order to give the reader a correct picture of the respective technologies potential merits, it needs to be made clear what degree of technical maturity these respective numbers refer too. (Government of Sweden)	Accept
4-665	A	25	1	0	0	Does Yugoslavia still exist? (Heleen de Coninck, Energy research Centre of the Netherlands)	Accept
4-666	A	25	5	0	0	This section would be more balanced if some words are devoted to the impact of coal mining and transport, in terms of environmental pollution (water, land use, air) and in terms of greenhouse gas emissions. (Heleen de Coninck, Energy research Centre of the Netherlands)	Reject – yes but not here
4-667	A	25	7	25	9	Peat is dismissed in two sentences whereas there are large reserves of burnable peat. Canada has over a billion tonnes of proven peat reserves with a further 300 billion tonnes inferred. Using a specific energy intensity of 5MJ/kg results in a resource of 1500 EJ see http://www.worldenergy.org/wec-geis/publications/reports/ser/peat/peat.asp (David Jackson, McMaster University)	Accept – add to table

4-668	A	25	12	25	0	There is no section 4.7.4 in the chapter?? (John Kessels, Energy Research Centre of the Netherlands)	Accept – should be 4.5.4 – well done John
4-669	A	25	12	0	0	Remove the word 'clean' before coal technologies as this is misleading see Dr Diesendorf, M, (2003) Australia's polluting power: Coal-fired electricity and its impact on global warming, WWF, p.8 and Ellis, M (1997) Can Coal be Clean?, AIDWATCH and Greenpeace Australia. (Kirsten Macey, Climate Action Network Europe)	Accept
4-670	A	25	12	0	0	The statement "The implementation of modern high-efficiency and clean utilization coal technologies is key to the development of economies, to minimize effects on society and environment (section 4.7.4)" seems presumptuous and unproven. I can't see where the citation goes to, since the chapter seems to end at 4.7 with no section 4.7.4. There are a lot of ways to develop economies, and most research has shown that coal plants don't bring particularly high economic development benefits with them compared to other options. I would suggest rewording to say that more efficient coal technologies combined with CCS could be an important part of an effort to reduce CO2 emissions, but to call new coal technologies key to anything is just not supported. (Steve Clemmer, Union of Concerned Scientists)	Reject – editorial, no reference
4-671	A	25	12	0	0	The statement "The implementation of modern high-efficiency and clean utilization coal technologies is key to the development of economies, to minimize effects on society and environment (section 4.7.4)" seems presumptuous and unproven. I can't see where the citation goes to, since the chapter seems to end at 4.7 with no section 4.7.4. There are a lot of ways to develop economies, and most research has shown that coal plants don't bring particularly high economic development benefits with them compared to other options. I would suggest rewording to say that more efficient coal technologies combined with CCS could be an important part of an effort to reduce CO2 emissions, but to call new coal technologies key to anything is just not supported. (Steve Clemmer, Union of Concerned Scientists)	See 4-670
4-672	A	25	12	26	2	Seems heavily focused on IGCC vs other advanced generation technologies. (Joanna Lewis, Pew Center on Global Climate Change)	Accept – Clive will write up on supercriticals
4-673	A	25	15	0	0	"4500 GW, of which 2400 in developing countries" (see page 20) (Heleen de Coninck, Energy research Centre of the Netherlands)	Accept
4-674	A	25	16	0	0	Please expand CSIRO (Ajay Guha, Asian Development Bank)	Accept

4-675	A	25	16	25	21	While it is nice that CSIRO has undertaken this study, the only part relevant to this report is the use of combined cycle technology, which could increase the efficiency of the plant…otherwise, a laundry list of the general environmental benefits of all of the technology options considered here would be required for balance. Suggest omission (Steve Sawyer, Greenpeace International)	See 4-681
4-676	A	25	16	25	16	Insert the following text: Gross, et al. (2003) report on the development of oxy-fuel combustion technology that provided an 11% improvement in the efficiency of an 0.5 MW natural gas-fired boiler. This technology, which provides a low NOx exhaust suitable for carbon capture and storage, has also been demonstrated in coal-fired boilers. (A copy of the reference is attached.) (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accept
4-677	A	25	16	25	21	The option mentioned is really new, not yet applied anywhere and its cost are unclear. I would take it out, given the very short section on coal, other issues are of much higher importance. (Dolf Gielen, International Energy Agency)	See 4-681
4-678	A	25	17	25	21	Delete as this is a still unproven technology and also CSIRO is not referenced in the references (John Kessels, Energy Research Centre of the Netherlands)	See 4-681
4-679	A	25	17	25	21	The paragraph around reference CSIRO (2005) must be deleted. Why a single factsheet of a specific project at CSIRO deserves a nice little paragraph in a one page summary of all coal technologies?????? We are in a section on coal technologies, where existing combustion technologies, and their developing paths towards higher steam conditions and efficiencies (ultrasupercritical boilers), deserve just one sentence or are not mentioned (fluidized beds), despite accounting for thousand (pulverised combustion) or hundreds (fluidized beds) of GW of installed capacity around the world and despite being some of the largest sources of CO2 emmisions. It is embarassing to see in a one page overall summary on "coal technologies" such an irrational and bias coverage of coal technologies. Why all the others factsheets on exciting new projects in the CSIRO web page, or in the US DoE web pages, or in the EU or Japan research programs web-pages are not mentioned like this specific CSIRO (2005) lucky project ???. This would be a minor point/mistake if it was not because I pointed out this in the review of the FOD, and the LA in charge of this section has chosen to ignore the comment and mantain his irrational bias/preference towards this specific project at CSIRO ¡¡¡¡ .	Noted – will see to the bias

						This is an improper aptitude in a LA of an IPCC report. REVIEW EDITORS AND FELLOW Lead Authors MUST READ CRITICALY THIS COMMENT AND ASK THE Lead Author INVOLVED FOR A JUSTIFICATION. (JUAN CARLOS ABANADES, INCAR-CSIC)	
4-680	A	25	17	25	21	'Ultra-clean coal' is not a substitute for conventional coal in conventional power stations. Its major application is in areas where conventional coal cannot be used: as an alternative for heavy fuel oil and gas in a gas turbine. Promoting 'ultra-clean coal' as a means of continuing with coal-fired power stations is misleading. Furthermore, from the figures given by researchers, ultra-clean coal, even when burnt in an advanced combined-cycle power station, produces much more greenhouse gas emissions than natural gas. Dr Diesendorf, M, (2003) Australia's polluting power: Coal-fired electricity and its impact on global warming, WWF, p.8 and Saddler, H; Diesendorf, M and Denniss, R (2004) A Clean Energy Future for Australia, WWF p. 123. (Kirsten Macey, Climate Action Network Europe)	See 4-681
4-681	A	25	17	0	0	This needs more explanation, why are unit emissions of GHG 24% lower, but total reduction only 10%. IS the 10% a global mitigation estimate? It is not clear. (Michael Taylor, International Energy Agency)	Accept – needs clarification
4-682	A	25	17	25	21	Delete whole paragraph starting "A CSIRO (2005) project...". Whilst interesting, this is just one of many possible ways to improve the efficiency of power generation from coal and should not be singled out in this report. (Brian Ricketts, International Energy Agency)	See 4-681
4-683	A	25	17	0	0	Mention is made under technologies (Section 4.3.1.1) on CSIRO's ultra clean coal. It may be worth while if all the technologies pursued under high efficiency clean coal technologies are mentioned. The Future Gen of US, Hypogen of EU, IGCC in Japan etc. are advanced designs and must find their mention in the report. Besides the gasification routes, the technologies under ultra super critical, oxy fired combustion technologies also may be included with brief description (Government of India)	See 4-681
4-25	B	25	17	25	21	Inconsistency: Paragraph claims 24% reduction in GHG emissions in line 19 and then 10% in line 21. (Government of Australia)	See 4-681
4-684	A	25	18	25	21	Lots of questions here. First, does it reduce GHG by 24% or 10%? Is the first number for IGCC and the second for conventional? This needs to be clarified. Also, is this being investigated by the CSIRO project or do we already know this.	See 4-681

						If so, what is the source? How much of the benefit is from the switch to gasification and how much from the coal? How do you define UCC, and how much of it is there? If this can really make a difference, there should be some discussion of supply. I believe there are some Asian coals with more hydrogen, thus more energy than just from the carbon, but if that's what you mean it won't help cut emissions in other parts of the world. (Steve Clemmer, Union of Concerned Scientists)	
4-685	A	25	18	25	21	Lots of questions here. First, does it reduce GHG by 24% or 10%? Is the first number for IGCC and the second for conventional? This needs to be clarified. Also, is this being investigated by the CSIRO project or do we already know this. If so, what is the source? How much of the benefit is from the switch to gasification and how much from the coal? How do you define UCC, and how much of it is there? If this can really make a difference, there should be some discussion of supply. I believe there are some Asian coals with more hydrogen, thus more energy than just from the carbon, but if that's what you mean it won't help cut emissions in other parts of the world. (Steve Clemmer, Union of Concerned Scientists)	See 4-681
4-686	A	25	18	0	0	0.25% of what? (Heleen de Coninck, Energy research Centre of the Netherlands)	Reject – comment meaningless
4-687	A	25	18	25	21	Misleading formulation on the use of UCC, because for specific greenhouse gas reduction two different results are mentioned. (Wilhelm Kuckshinrichs, Forschungszentrum Juelich GmbH)	See 4-681
4-688	A	25	19	25	21	Two different statements about the reduction in GHG emissions are made in the same sentence. (Danny Harvey, University of Toronto)	See 4-681
4-689	A	25	19	25	21	"……..greenhouse gas emissions by 24% per kWh …….up to 10%.". Which % is correct here? (Government of India)	See 4-681
4-26	B	25	19	25	31	This sentence is either unclear or internally inconsistent and repetitive - does Ultra-Clean Coal reduce greenhouse gas emissions by 24% relative to conventional coal or 10%? (Government of Australia)	See 4-681
4-690	A	25	23	25	26	Coal is not converted to electricity, carbon capture and sequesteration has not been	Reject – coal is converted to electricity

						done commercially (Ajay Guha, Asian Development Bank)	Accept – CCS has not been done
4-691	A	25	23	25	30	You should maybe also mention the US FuturGen project in this paragraph. (Michael Taylor, International Energy Agency)	Accept
4-27	B	25	23	25	23	Paragraph incorrectly describes gasification as "sequestering CO2 emissions from the flue gas where that is conducted". Gasification enables pre-combustion capture and the CO2 is separated and captured prior to combustion (and not from the flue gas). (Government of Australia)	Will reword
4-692	A	25	25	25	30	Are these estimates based on paper work or on actual experience ? (Government of France)	Noted – based on demos
4-693	A	25	26	25	27	It is important to point out that IGCC is not yet commercial and that currently there are only 5 plants (Buggenum, Puertollano, Wabash River, Polk and Delaware although this one does run on oil) with a total generation capacity of 1305MW in operation around the world. I would also suggest to add that the age of coal fired plant will also have an impact on emission reduction and once they are built their is little realistic options to retrofit plants for emission reductions or to make them capture ready (John Kessels, Energy Research Centre of the Netherlands)	Accept
4-694	A	25	26	25	27	Replace "...reduce conventional combustion emissions." with "...reduce all emissions". It is not just SO2, NOx and dust that is reduced, efficiency improvements mean that CO2 emissions are also reduced. (Brian Ricketts, International Energy Agency)	Accept
4-695	A	25	26	25	26	After "(IGCC) systems" insert "and conventional combustion systems". The paragraph is otherwise too biased towards IGCC. (Brian Ricketts, International Energy Agency)	Accept
4-28	B	25	26	25	0	Note: reviewer suggested page. Add: "In the longer term, beyond 2030, much greater supplies of non-C02-emitting energy will be needed, of order 150 EJ/year in 2050, 500 EJ/year in 2100 and 1000 EJ/year in the next century. The total requirement until 2200 is in the range of 100,000 EJ. Table TS 10 provides a perspective on the options to provide these levels of energy." [Copy Table 4.3.1 here.] U.S. Government Note IPCC SRCCS page 12 as source for primary energy use. (Government of U.S. Department of State)	Noted

4-696	A	25	28	25	34	To my knowledge an efficiency of 55% for coal fired IGCC has not been reached anywhere commercially in the world. The best available technology reference document of the European Commission (BREF-LCP, see: http://eippcb.jrc.es/cgi-bin/locatemr?lcp_final_0505.pdf) refrains from giving representative values for this technology (because only a limited number of plants are employed worldwide). The same BAT-document gives as an upper limit for best coal fired plants of 47% and substantiates this value. (Walter Ruijgrok, EnergieNed)	accept
4-697	A	25	28	25	34	55% efficiency for IGCC and 48.5% for SC pulverized coal is much higher than estimates we've seen in other reports. (Steve Clemmer, Union of Concerned Scientists)	accept
4-698	A	25	28	25	34	55% efficiency for IGCC and 48.5% for SC pulverized coal is much higher than estimates we've seen in other reports. (Steve Clemmer, Union of Concerned Scientists)	See-697
4-699	A	25	28	25	28	After "typical steam plants" insert "to above 45% in commercial supercritical steam plants and...". The paragraph is otherwise biased towards IGCC and quotes IGCC efficiencies that have never been attained (i.e. 55% is only the potential efficiency of a paper design). (Brian Ricketts, International Energy Agency)	accept
4-700	A	25	29	25	30	“significant” is too vague. Give the percentage reductions, which can be readily worked out from the efficiencies. (Danny Harvey, University of Toronto)	accept
4-701	A	25	29	25	29	The cited (Equitech, 2005) web-site does not exist (Government of Germany)	Noted – check references
4-702	A	25	30	25	30	Add "dioxide" after "carbon" (Ajay Guha, Asian Development Bank)	accept
4-703	A	25	31	25	34	Supercritical plants are a different technology to gasification - a clearer distinction in the text should be made (e.g. new paragraph). The implication of the text "The development of new materials will alllow...." is that supercritical plants have not been developed yet. This is contradicted by the next sentence. It is worth noting that supercritical technologies are the standard new build power plant in China, with more than 10 in operation by 2003. (IEA Clean Coal Centre 'Coal in China', 2004). Suggest addition of sentence "Supercritical plant offer significant efficiency improvements over conventional plant, and bring associated emissions reductions" before "The best plants currently commercially available..."	Noted – change text to “new materials allow ...”

						(Christine Copley, World Coal Institute)	
4-704	A	25	35	25	35	please add: An overview concerning the whole scope of so called clean coal technologies is given by COORETEC on http://www.fz-juelich.de/ptj/projekte/index.php?index=1372; the presentations of international conferences and workshops dealing with these issues are available under: http://www.fz-juelich.de/ptj/projekte/index.php?index=1369 (Government of Germany)	Noted – add reference
4-705	A	25	36	0	0	Please expand CTL. (Ajay Guha, Asian Development Bank)	noted
4-706	A	25	36	25	42	It should be noted here that most CTL applications result in a substantial increase in GHGs, absent any effort to separate, capture, and store CO2. (Kelly Sims Gallagher, John F. Kennedy School of Government, Harvard University)	accept – add quote
4-707	A	25	36	26	2	The whole discussion of coal to liquids seems to miss the point. If we start making liquid transportation fuels out of coal rather than petroleum, we will be increasing our net CO2 emissions, if you add in the emissions at the plant and those at the vehicle. This should be clarified. I would also suggest noting that with CCS, you might be able to get emissions back down to something closer to petroleum, but even then it is a step backward because we have to store the captured carbon, and we probably won't capture all of it. (Steve Clemmer, Union of Concerned Scientists)	See 4-706
4-708	A	25	36	26	2	The whole discussion of coal to liquids seems to miss the point. If we start making liquid transportation fuels out of coal rather than petroleum, we will be increasing our net CO2 emissions, if you add in the emissions at the plant and those at the vehicle. This should be clarified. I would also suggest noting that with CCS, you might be able to get emissions back down to something closer to petroleum, but even then it is a step backward because we have to store the captured carbon, and we probably won't capture all of it. (Steve Clemmer, Union of Concerned Scientists)	See 4-706
4-709	A	25	36	25	42	Note the environmental (esp. climate) implications of CTL? (Joanna Lewis, Pew Center on Global Climate Change)	See 4-706
4-710	A	25	36	0	0	Define CTL (Danny Harvey, University of Toronto)	noted
4-711	A	25	36	0	0	Under CTL (4.3.1.1), the route of conversion of coal to liquid using steam	Accept – Turner will find references

						hydrolysis and steam reformation of coal under reducing conditions does not find its mention. This process may be included in CTL. (mention of CTL and GTL is important and must be given proper focus) The efficiency numbers and cost figures may need some more back up through reference or calculations. (Government of India)	
4-712	A	25	36	25	36	Insert 'done' after "Coal Liquefaction can be… (Government of India)	Accept – insert 'performed'
4-713	A	25	36	25	36	The term CTL first encountered here is defined page 29.line 22 only (Government of France)	noted
4-714	A	25	36	22	36	CTL is not defined! what does it mean? is it perhaps "Coal To Liquid"? (Government of Germany)	noted
4-29	B	25	36	25	42	There is no discussion on the greenhouse implications on using CTL or GTL compared with using crude oil. This is critical as there is currently significant uncertainty on the GHG benefits offered by CTL and GTL (eg similar point is made about unconventional oil – page 29 line 25-26). (Government of Australia)	See 4-706
4-715	A	25	39	25	42	This sentence is incomprehensible. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accept - rewrite
4-716	A	25	39	25	42	This last sentence is not clear, and needs reworking. Also I'm not sure that the Fischer Tropsch process for coal is really expected to achieve 67% efficiency. The data the IEA has suggests 50% maybe a realistic target. (Michael Taylor, International Energy Agency)	Accept – change to 50% and refernce IEA ETP (2006)
4-717	A	25	39	25	42	Difficult to understand the sentence; (DELLERO Nicole, AREVA)	See 4-715
4-718	A	25	39	25	42	Difficult to understand the sentence; (DELLERO Nicole, AREVA)	See 4-715
4-719	A	25	39	25	42	"These produce ……by around 10%". Some discontinuity is appearing in the text; slight rephrasing needs to be done for clarity. (Government of India)	See 4-715
4-720	A	25	39	25	42	This sentence is incomprehensible. U.S. Government (Government of U.S. Department of State)	See 4-715
4-721	A	25	44	25	47	Needs to be supported by analyzed data in footnote (Ajay Guha, Asian Development Bank)	Accept – needs reference
4-722	A	25	44	25	44	The present costs are much higher	See 4-721

						(Government of France)	
4-723	A	25	46	0	0	Define GTL (Danny Harvey, University of Toronto)	noted
4-724	A	25	46	25	46	The term GTL first encountered here is defined page 29.line 22 only (Government of France)	noted
4-725	A	26	1	26	2	Needs to be supported by analyzed data in footnote (Ajay Guha, Asian Development Bank)	Accepted – needs reference
4-726	A	26	1	0	0	Presumably this is Gt C of coal. If not, convert to Gt C, and state the units as such (Danny Harvey, University of Toronto)	Noted – confirm units
4-727	A	26	1	26	2	A 2-4 Gt coal reserve could potential supply an 80,000 bpd CTL plant for between 125 and 250 years. The statement about the size of coal reserve needed is therefore suspect since the plants are economic over much shorter investment horizons. (Brian Ricketts, International Energy Agency)	Noted - confirm
4-728	A	26	2	0	0	"available" can be deleted. (Danny Harvey, University of Toronto)	accept
4-729	A	26	8	26	8	Delete just (John Kessels, Energy Research Centre of the Netherlands)	accept
4-730	A	26	22	26	23	"Despite .. worldwide". It may be true that the capacity currently built contains much gas-fired installations, but the question is to what extent they will be used if gas prices remain high. Maybe the authors can reflect a bit on that. (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – perhaps WEO2006 can shed light on this
4-731	A	26	22	26	28	It is recommended that either the citations of the IEO2005 to the IEO2006 forecasts be updated or replace them with the World Energy Outlook 2004 forecasts. Rationale: The authors have used the IEA's forecast throughout, if seems quite odd to switch to EIA's IEO2005 for this single paragraph. If the authors choose to use the IEO forecast, switching to the IEO2006 (which has the same forecast horizon to 2030 as the IEA's Outlook) would make for a more consistent picture. U.S. Government (Government of U.S. Department of State)	Accept – consistency important
4-732	A	26	23	0	0	I would try to include the IEA World Energy Outlook 2006 projections here, the outlook for gas is probably not as good as it was even a year ago. (Michael Taylor, International Energy Agency)	accept
4-733	A	26	30	0	0	include 'fossil fuels' between 'other technologies'. (Kirsten Macey, Climate Action Network Europe)	accept

4-734	A	26	32	0	0	Natural gas based power plants are generally costlier than coal fired power plants (Ajay Guha, Asian Development Bank)	Noted – CCGT are whereas OCGT are not
4-735	A	26	32	0	0	Define CCGT (Danny Harvey, University of Toronto)	noted
4-736	A	26	34	26	38	The investment cost data for CCGTs can be seen by NEA/IEA, Projected Costs of Generating Electricity - 2005 Update, 2005. The literature have been refered in Section 4.4.2, and therefore I suggest that this paragraph should integrate into Section 4.4.2 (p.77). (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	accept
4-737	A	26	36	26	37	Efficiencies indicated for CCGTs in the range of 50-58% are too high (Ajay Guha, Asian Development Bank)	Reject – no references BUT cited reference DEAT (2004) is wrong!
4-738	A	26	36	26	36	The CCGT investment cost quoted is EUR/kW not EUR/MW (Brian Ricketts, International Energy Agency)	accept
4-739	A	26	37	26	37	The CCGT investment cost quoted is EUR/kW not EUR/MW (Brian Ricketts, International Energy Agency)	accept
4-740	A	26	38	26	40	It is "H" designs of gas turbine that have steam cooled blades, not "G" designs. (Brian Ricketts, International Energy Agency)	accept
4-741	A	26	0	0	0	New class designs in GT are “H” class and this does not find its mention in the report under methane fuel chapter (4.3.1.2) (Government of India)	accept
4-742	A	27	0	27	0	Table 4.3.2: How is evaluated the unconventional gas resource ? The figure quoted seems high and is certainly very uncertain. (Government of France)	Noted – but material referenced
4-743	A	27	1	27	8	Any LNG figures for Europe or Asia? (John Kessels, Energy Research Centre of the Netherlands)	noted
4-744	A	27	1	0	0	Explain what the Pacific Basin is and where it is. (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – this is not geography
4-745	A	27	1	27	7	, t is recommended that the forecast to the Annual Energy Outlook 2006 be updated. U.S. Government (Government of U.S. Department of State)	accept
4-746	A	27	4	27	6	“Again, point estimates, US ranges or “BAU” or what scenario reference?” U.S. Government (Government of U.S. Department of State)	Accept – move refernce to USEIA 2005

4-747	A	27	5	27	6	"Energy loss during the LNG liquefaction process is estimated at 7 to 13% of withdrawn natural gas, a larger loss than typical of pipeline transportation over 2,000 km." From the wording of this sentence, it is unclear whether the 7 to 13% loss is referring to the Btu consumed in the process, or to a loss of natural gas as fugitive methane emissions. If it is referring to the energy consumed in the process, rephrasing is suggested, such as, "The energy consumed during the LNG liquefaction process is estimated at 7 to 13% of the Btu content of the withdrawn natural gas …" However, if the reference is instead intended to refer to fugitive methane emissions, the CO2-equivalent of this methane loss (given methane's high GWP) could exceed the CO2 emissions from the methane that is ultimately consumed by the end-users. If that is the case, then it certainly needs to be discussed more fully, as that could make the life-cycle emissions of LNG higher. U.S. Government (Government of U.S. Department of State)	Accept – add energy to loss in l6
4-748	A	27	6	0	7	Not sure I agree that LNG would increase the amount of methane released to the atmosphere, it is one of the most physically contained forms of energy. (Chris Mottershead, BP)	Accept – drop the last sentence
4-749	A	27	10	27	14	Can you say something on the projected future use of LPG, e.g. in the transport sector? What is the potential for its use? If not, argue why it is so unimportant that only four lines are required to describe the fuel. (Heleen de Coninck, Energy research Centre of the Netherlands)	Reject – for ch5 transport
4-750	A	27	10	27	10	Change "methane" to "propane." There is essentially no methane in LPG, but it often contains a high fraction of propane. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	accept
4-751	A	27	10	27	10	Change "methane" to "propane." There is essentially no methane in LPG, but it often contains a high fraction of propane. U.S. Government (Government of U.S. Department of State)	accept
4-30	B	27	10	27	10	LPG is a mixture of propane, propylene, butane, and butylene in various proportions according to its state or origin. Describing LPG as a mixture of methane etc is incorrect. (Government of Australia)	accept
4-752	A	27	15	27	25	Information here needs to be more effectively linked to information in Table 4.3.2 (Ajay Guha, Asian Development Bank)	noted
4-753	A	27	21	0	0	Why is the United States suddenly singled out as a CBM user? Aren't there numbers on China, Europe? If it's a lack of literature, please indicate so	Noted – but this is the reference material

						(Heleen de Coninck, Energy research Centre of the Netherlands)	
4-754	A	27	22	27	22	Is this just CBM or does it include CMM as well? (John Kessels, Energy Research Centre of the Netherlands)	Noted – standardize on CBM
4-755	A	27	22	27	22	The text that US estimate are 800EJ and that given in Table 4.3.2 741EJ does not match. The difference of 60 EJ is nearly 4 times the current total primary energy consumption of India to put it in perspective. Although the number in question here is only the reserve number but the reporting inconsistency should be zero as far as possible. (Government of India)	Noted – but these are estimates
4-756	A	28	2	0	0	Indicate adverse effects of methane as compared to CO2 (Ajay Guha, Asian Development Bank)	Noted – space limited
4-757	A	28	7	28	16	Note the environmental (esp. climate) implications of GTL? (Joanna Lewis, Pew Center on Global Climate Change)	See 4-706
4-758	A	28	7	28	0	The meaning of the abbreviation "GTL" should be stated in the text. (Government of Japan)	accept
4-31	B	28	7	28	16	The authors need to include discussion on the greenhouse implications of using GTL compared with using crude oil. (Government of Australia)	See 4-706
4-759	A	28	12	0	0	Although many GTL plants have been announced or under construction, I think the only plant that is not a demonstration plant is the Shell Malaysian plant, which is only 14,000 bpd. I am sure production of GTL is not 0.58Mbbl/day (Chris Mottershead, BP)	Noted – but space limited and no reference
4-760	A	28	12	28	13	It is recommended that the citation to the FACTS 2006 “Gas Databook” be updated. Rationale: The FACTS “Gas Databook” for 2006 is available and includes a downward revision to Qatar’s GTL production by 2012. U.S. Government (Government of U.S. Department of State)	accept
4-761	A	28	16	0	0	Indicate publisher of Annual Energy Outlook 2001 (Ajay Guha, Asian Development Bank)	Reject – in the references

4-762	A	28	16	0	0	To be comparable to the CTL section I would add the sentence "GTL technologies are around 55% efficient, while production costs vary depending on gas prices. If stranded gas is avaibale at US$ 0.5/GJ production costs are around $30 a barrel (IEA 2006). The figure you have of GTL being competitive at $20 a barrel loooks too low, perhaps you may want to delete that reference and use the IEA Energy Technology Perspectives reference given. (Michael Taylor, International Energy Agency)	accept

Comments on section 4.3.1.3 - 4.3.1.4 Inga

4-763	A	28	20	29	17	As far as I cen see this is the only section that touches on oil peaking and supply security. However its message is totally unclear. If you want to save space, I would delete it. If you want to address supply security properly it needs a rewrite, more on location of oil reserves etc. Also gas supply security should be mentioned, a big issue in eg Europe. (Dolf Gielen, International Energy Agency)	Noted
4-764	A	28	20	28	20	Does the author really intend to define “conventional oil” as “crude oil?” Since uncertain about what the distinctions of the primary, secondary, or tertiary methods include—are NGL’s included? Lease condensates? Rationale: EIA usually includes NGL’s, lease condensates, and refinery gain as “conventional.” U.S. Government (Government of U.S. Department of State)	Noted – will be checked
4-765	A	28	21	28	21	"Oil represents about 34% …….". Refer page 24 line 14 reporting oil share of 37% from BP statistics – it might be a good idea giving the range based on various statistics; A different number at different places confuses the reader. (Government of India)	Accepted – consistency should be ensure
4-766	A	28	26	28	27	Suggestion: Change “New discoveries have lagged behind production for more than 20 years (IEA, 2005).” to “While new discoveries have lagged behind production for more than 20 years, reserve additions from all sources (i.e., discoveries, extensions, and revisions) continue to regularly outpace production (IEA, 2005b).” Reason: First, note the citation change, (IEA, 2005, to IEA 2005b). The original citation is a biofuels document. Second, while it is true that new discoveries have lagged behind production, the sentence fails to acknowledge the notion of reserve growth. The sentence claims that discoveries have lagged production for 20 years. While technically true, it is misleading to regarding total changes in reserves because ‘discoveries’ are simply an initial estimate of the resources in a newly	Accepted

						found area. Reserve additions, which can be computed as R(t)-R(t-1)+Q(t), where R is reserves and Q production, from all sources (i.e. discoveries, extensions, and revisions) continue to regularly outpace production. (Russell Jones, API)	
4-767	A	28	29	28	31	"As conventional oil supplies become……..environmental impact costs". These lines don't seem to belong in this section at all. (Government of India)	Rejected – mistake in section number 4.3.1.4
4-768	A	28	29	28	31	Please make a figure just as 4.3.2 but then for fossil fuels. More discussion on fossil fuel prices and peak oil discussion is required. (Government of European Community / European Commission)	Noted
4-769	A	28	30	28	31	Do you mean "environmental impact AND costs"? (Danny Harvey, University of Toronto)	Accepted
4-32	B	28	31	28	31	The sentence refers to section 4.3.2.4. This section refers to "Development of future nuclear-power systems" and the reference appears to be incorrect. (Government of Australia)	Accepted Reference should be corrected from 4.3.2.4 to 4.3.1.4
4-770	A	28	33	28	37	Paragraph seems to be incomplete! (Government of India)	Noted
4-771	A	28	39	29	14	The significance of these figures (taking the serious top of the range as 4000 Gbbl, not 6000 Gbbl) seems to have been missed. If total available (recoverable) conventional oil reserves plus resources are around 10,000 EJ (say, 1.8 trillion barrels, or 1800 Gbbls) then conventional oil availability will fall short of widely projected global demand by 2020! Thus the reference to 70 years supply is very misleading, and the reference to 40 years supply is not "a reasonable estimate" but rather a seriously over-optimistic statement. (Michael Jefferson, World Renewable Energy Network & Congresses)	Rejected – no references
4-772	A	28	41	0	0	Please include the terms "reserves (proven, probable, and possible)" in the glossary. (Heleen de Coninck, Energy research Centre of the Netherlands)	Rejected
4-773	A	28	42	0	0	When I look at Fig. 4.3.1 I see four points (=results from studies) close to 500 Gbbl - admittedly they are quite old - and all others besides one are below 4000. Is it appropriate to say '... less than 5730 EJ to 34000 EJ (1000 to 6000 Gbbl), though ...' ? (Manfred Treber, Germanwatch)	Rejected – four points close to 500 Gbbl are very old (1940-1950)
4-774	A	28	46	0	0	"trend" should be "estimate"	Accepted

						(Danny Harvey, University of Toronto)	
4-775	A	29	0	29	0	Figure 4.3.1 add "measure units" (EJ, Gbbl, ton, toe, ?) (José Somoza, National Institute of Economic Research)	Accepted
4-776	A	29	1	29	4	Figure 4.3.1, there are no unit. It is more interesting if you show the estimates of each institute on the figure. (Junichi Fujino, NIES)	Accepted
4-777	A	29	1	0	0	Give units in the caption (Danny Harvey, University of Toronto)	Accepted
4-778	A	29	1	29	3	Units of the vertical axis (probably Gbbl) are missing in Figure 4.3.1. (Muhammad Latif, Applied Systems Analysis Group)	Accepted
4-779	A	29	1	29	0	Add in the axes titles. U.S. Government (Government of U.S. Department of State)	Accepted
4-780	A	29	4	29	14	It is now established that, during the last years, although the oil exploration budget increased, there has been limited oil discoveries. Large oil fields have all been discovered and only small and expensive resources are still to be discovered. It has no sense to write that reserves are sufficient for about 70 years supply at present rate, as it was shown above that rates are still increasing and will continue to increase in the future. One should rather show that that "peak oil" will occur in the coming 20 years (may be already!). It should also be mentioned that the prices will not remain low (as already observed now). If the curve of oil (or gas) depletion looks symmetrical (leaving the idea that we have more to exploit than already used), this is not at all tha case for the price curve : as the peak is approached, prices are strongly increasing (as observed now) and prices will increase even more in the declining period. Opportunities resulting from this situation should be exploited bu policy makers for radical changes in energy supplies and investments scenarii. (VARET jacques, French Geological Survey)	Noted
4-781	A	29	4	0	0	Define IFP (Danny Harvey, University of Toronto)	Accepted
4-782	A	29	6	0	0	Insert “that” after “concluded” (Danny Harvey, University of Toronto)	Accepted
4-783	A	29	9	0	0	While exploration may not have been fully replacing production improvements in recovery (including Enhanced Oil recovery) have been making a material contribution, and will do so for many decades, but do not get a mention.	Accepted

						(Chris Mottershead, BP)	
4-784	A	29	10	29	11	Semicolon before “however” and comma after. (Danny Harvey, University of Toronto)	Accepted
4-785	A	29	13	0	0	I would delete the last part of this sentence from "…, about two-thirds the amount released…." You haven't done the same comparison for coal, which would result in a much worse comparison, so why do it here? Y=The other option is to make the same calculation for coal and gas. (Michael Taylor, International Energy Agency)	Accepted
4-786	A	29	30	30	15	Heavy oil shale and tar sands together have an estimated recoverable volume of the order of 620-650 billion barrels, by comparison with the probable near 2 trillion for conventional oil. Not only is the unconventional oil resource relatively small (it could extend World oil availability by about 10 years in total), there are considerable environmental implications - and has Canada the natural gas volumes to exploit it fully (probably not)? (Michael Jefferson, World Renewable Energy Network & Congresses)	Noted
4-787	A	29	31	0	0	I believe the total resource in place of heavy oil in venezuela is more like 1200 Gb, with reserves of around 270Gb see IEA (2006). (Michael Taylor, International Energy Agency)	Noted – will be checked
4-788	A	30	6	30	9	This paragraph should not be placed between the discussions of Venezuela and Canada heavy oil resource which are similar. The feasibilty of exploiting oil shales remain an open issue. (Government of France)	
4-789	A	30	7	30	7	"…500 Gbbl of medium ……..95 1 of oil per tonne….." Please check this number (Government of India)	Noted – will be checked
4-790	A	30	10	0	0	Here and elsewhere, change “oil sands” to “tar sands” in order to more accurately reflect what is in the ground and the fact that these deposits are not readily useable. The convention outside Canada has been to use the term “tar sands”. (Danny Harvey, University of Toronto)	Accepted
4-791	A	30	12	30	12	It is better to clarify the source on which the long-term production of Canadian oil sands is based. According to the latest forecast of CAPP (Canadian Association of Petroleum Producers), prestigious association about oil sands forecast, in attached file ”CAPP.pdf”, Oil sands production, which now exceeds one million b/d, is forecast to reach 2.15 million b/d by 2010, 3.5 million b/d by 2015 and 4.0 million	Accepted – will be checked

						b/d by 2020, accounting for more than 80 % of Canadian production. The source is available in the following website. http://www.capp.ca/raw.asp?x=1&dt=NTV&e=PDF&dn=103586 (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	
4-792	A	30	15	0	0	Add at the end of this paragraph "Extraction of bitumen from the Alberta oil sands requires large quantities of natural gas. Thermal in situ extraction requires 900 to 1,200 cubic feet of natural gas per barrel of bitumen and extraction of mined bitumen needs 200 to 300 cubic feet per barrel. Upgrading consumes an additional 300 to 700 cubic feet per barrel. " ref: http://www.centreforenergy.com/generator2.asp?xml=/silos/ong/oilsands/oilsandsAndHeavyOilOverview01XML.asp&template=1,1,1 (David Jackson, McMaster University)	Accepted
4-793	A	30	20	0	0	The oil sands are either cleaned and diluted (usually with naptha) or sent to an upgrader to yield syncrude (see NEB 2006). (Michael Taylor, International Energy Agency)	Noted
4-794	A	30	23	30	24	Delete para break (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-795	A	30	23	30	23	delete [No paragraph break] (Stefano Caserini, Politecnico di Milano)	Accepted
4-796	A	30	23	30	24	Clean (Government of France)	Accepted
4-797	A	30	23	20	26	Why use $5/bbl? References? U.S. Government (Government of U.S. Department of State)	Accepted – add reference
4-798	A	30	25	0	0	You need to add that new greenfield projects for oil sands are currently much more expensive than this and require around $30-35/bbl WTI prices due to project cost inflation in recent years (see NEB 2006). (Michael Taylor, International Energy Agency)	Accepted – ref. will be checked
4-799	A	30	34	0	0	Maybe it is appropriate to state here that Canada's huge increase in GHG emissions is largely due to the enhanced exploitation of tar sands in Alberta. It plays a significant role in Canada's likely non-compliance with the Kyoto Protocol. (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted

Comments on section 4.3.2 Nuclear Energy; Seppo + Yohji

4-800	A	30	35	35	30	This section on nuclear is very long compared to for instance that for non-conventional oil. I would suggest shortening it. (Michael Taylor, International Energy Agency)	Rejected The multitude of issues related to nuclear energy requires broader discussion
4-801	A	30	36	0	0	Section 4.3.2 Nuclear Energy Though nuclear energy is a very politically controversial problem, this section succeeds to treat it neutrally from the scientific basis. It would be recommended that a brief description about uranium resources in sea water be added. Since the share of the electricity in the energy consumption is projected to increase, the role of nuclear energy will become more inportant. The commercialization of electric vehicles or FCV has a strong potential for the use of nuclear energy. (Ryota OMORI, Japan Science and Technology Agency)	Noted The discussion of this particular uranium resource was intentionally left out in SOD, but might be mentioned very briefly, however not included in the diagram (Fig. 4.3.2) Hydrogen production by nuclear has been mentioned in Ch 4.3.2
4-802	A	30	37	0	0	The presentation of nuclear electricity (16-17% of the world total) in line 37 is not consistant with the large hydro production (i.e. 6% of the world total)… Consistency should be to use in both cases figures in electricity production (in TWh) (see p.35 l35 and p38) (ANTOINE BONDUELLE, Université Lille II)	Noted It is correct that share of nuclear in total electricity supply is 16-17%. and share of hydro power is roughly the same. However, using the standard IEA practice in conversion of electricity to primary energy, the thermal efficiency (33%) of a NPP is taken into account but for hydro power 100% conversion efficiency is assumed. As a result of this the primary energy shares of nuclear and hydro are dissimilar to those presented in electrical energy terms. Both perspectives could be presented systematically
4-803	A	30	38	32	4	This section on nuclear power plant technologies seems out of place. It seems that the section on uranium resources 4.3.2.1 should be here in this larger section about natural resources. The text about nuclear power plant technologies belongs elsewhere. (James Dooley, Battelle)	Rejected Technological aspects must be also described in this subsection.
4-804	A	30	40	30	40	Add the International Energy Outlook 2006 and the IEA's World Energy Outlook 2004 as sources of nuclear capacity forecasts out to 2030. Rationale: both EIA and the IEA include capacity forecasts to 2030. U.S. Government (Government of U.S. Department of State)	Taken into account The suggestion will be followed.
4-805	A	30	44	30	45	According to IEA 2006 Energy Technology Perspectives:233 there are 443 nuclear plants operational with a total capacity of 370GW perhaps need to use this figure or	Taken into account Number of operational reactors will be

						check the WNA, 2006a figure (John Kessels, Energy Research Centre of the Netherlands)	updated to correspond the situation ikn October or November 2006.
4-806	A	30	45	0	0	I would have thought that France deserved a mention here, given its large percentage use of nuclear power, and possibly also Switzerland, which has virtually carbon free electricity production, with 60% hydro and 40% nuclear. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Noted France will be mentioned (owing to large share of nuclear). Furthermore, a decision has been made to construct an EPR unit in Flamanville
4-807	A	30	45	30	45	28 reactors under constuction' is misleading, as a large number of these have been 'under construction' for more than a decade and are unlikely to ever come on line. There are only 2 under construction in the OECD at present, the lowest for some decades. (IEA PRIS database) (Steve Sawyer, Greenpeace International)	Taken into account Possibilities to briefly qualify the construction delays among the 28 reactors will be considered.
4-808	A	30	45	0	0	The number of 28 plants "on construction" is misleading, because several of these reactors are not likely to be ever in operation. A better figure could be "new construction start has been in the last decade has been less than a reactor per year" (AIEA PRIS databank, various years) (ANTOINE BONDUELLE, Université Lille II)	Taken into account See response to comment A807
4-809	A	30	45	0	0	"Six plants were in long-term shut down" – this sentence does not work; what is meant here? (Heleen de Coninck, Energy research Centre of the Netherlands)	Taken into account Shortly expressed the situation is this. Brief description of the background for this situation could be considered to be added
4-810	A	30	46	30	48	noticeably absent from the list of 'proposed' reactors are those in Iran, Venezuela, N. Korea…in the interests of 'balance' please refrain from using 'information' about the future from the propaganda arm of the nuclear industry (WNA), unless you give equal weight to the projections from the renewable energy industry, which are produced with a great deal more rigor and which you have largely ignored to date. (Steve Sawyer, Greenpeace International)	Rejected WNA figures are consistent with those of the IAEA
4-811	A	30	46	30	46	The USA and France are the two countries which are the most involved in nuclear energy use and should be mentionned. (Government of France)	Taken into account Your comment will be inserted.
4-812	A	30	47	31	2	"In Japan 54 ….but immediate plans for construction of 13 new reactors have been scaled downed due to anticipated future reduced power from efficiency and population decline (METI 2005)" is assume to be referring to the "Prospect of Energy Demand and Supply in 2030" by METI, 2005. According to the original	Taken into account. The two sentences of "In Japan 54 …population decline(METI 2005)." Their target is now … 40% of electricity." are

						text, immediate (2010) plan is 3 plants and not 13. For long term (2030) prospect, additional 13, 6 and 4 plants during 2010 through 2030 according to 3 different scenarios (reference case, High-case and Low-case) respectively. (http://www.meti.go.jp/report/downloadfiles/g50328b01j.pdf page 116) Please refer to the original text. (Satoshi Yoshida, The Japan Gas Association)	replaced with " In Japan 55 nuclear reactors currently provide nearly a third of total national electricity and 7 to 16 new ones are predicted to be in operation until 2030 in order to provide the current level of nuclear energy supply (JAEC 2005)." Source; JAEC, 2005, Framework for Nuclear Energy Policy http://aec.jst.go.jp/jicst/NC/tyoki/taikou/kettei/eng_ver.pdf
4-813	A	30	47	31	4	There are now 55 nuclear power reactors in Japan. Another one is scheduled to commence operations in 2009. The next is not due to begin operations until 2011. Plans currently exist for 13 new reactors (17.23 Gwe). The last of these is scheduled to come on line in 2017, but since the schedule is pushed back each year, this should not be treated as indicative of what will actually happen. (See the following URLs: http://cnic.jp/english/data/futurereactors.html; http://cnic.jp/english/data/nucreactors.html) Japan's existing policy, as stated in Framework for Nuclear Energy Policy (Japan Atomic Energy Commission, October 11, 2005, English version p.29), is "to aim at maintaining or increasing the current level of nuclear power generation (30 to 40% of the total electricity generation) even after 2030." [Include reference for predicted 2030 Gwe] (Framework for Nuclear Energy Policy is available at the following URL: http://aec.jst.go.jp/jicst/NC/tyoki/taikou/kettei/eng_ver.pdf) (Kenichi Oshima, Ritsumeikan University)	Taken into account See response to comment A812
4-814	A	30	47	31	2	Delete this paragraph "In Japan 54 nuclear reactors … provide around 40% of electricity." and add this sentence "In Japan, 55 nuclear power reactors currently provide nearly a third of total national electricity, and one of them will be shut down in 2010. 13 new power reactors are planed to be constructed, and 9 of them will be in operation until 2015. Total installed capacity will be expanded from 50GW to 61GW until 2015." This is latest information of the Japanese nuclear reactors. (Government of Japan)	Taken into account

4-815	A	30	0	0	0	Under nuclear energy, mention of GNEP (Global Nuclear Energy Plant) does not find its mention. This is a new proliferation resistant technology which may be able to make the nuclear technology popular. The ITER also need to be included in the report to bring out the fusion part of nuclear energy (Government of India)	Noted ITER has already be included in this section.
4-816	A	31	1	31	2	Draft says "… scaled down due to anticipated future reduced power demand from efficiency and population decline." It is illogical the efficiency decline cause the reduced demand. This sentence should be fixed as follows; "… scaled down due to anticipated future reduced power demand from efficiency improvement and population decline." (Government of Korea)	Noted
4-817	A	31	3	31	3	In the paragraph you are speaking indistinctly of nuclear plants and of nuclear reactors. In the Japan case you are speaking of reactors but in line 3 of this page you ends telling "adding four plant by 2010…". How many reactors these new plants are equal? (José Somoza, National Institute of Economic Research)	Noted The text will be checked so that consistently the number of reactors and not power plants will be used
4-818	A	31	6	31	7	"China has purchased thousands of tonnes..". This is vague – could be 2 thousand tonnes or 999 thousand tonnes. Numbers would provide clarity (Christine Copley, World Coal Institute)	Taken into account Is it possible to provide a figure in detail? see also later comment ??
4-33	B	31	6	31	7	Delete this sentence as it is incorrect as China has not purchased any uranium from Australia yet. (Government of Australia)	Noted Information needs to be checked and text modified accordingly
4-819	A	31	7	0	0	This sentence needs to be expanded to reflect the fact that India is a country looking at all sources of energy to provide energy security and ensure economic growth at 8% above. Scenario for the growth of enrgy requirement was first developed by Grover and Chandra (2006) and it was read by policy making bodies in India and a committee was set up under the Chairmanship of Member (Energy), Planning Commission. The report of this committee has been just released and for growth of nuclear energy, it relies on the scenario given by Grover and Chandra. In addition, one reactor under construction has been connected to grid and now only 7 reactors are under construction. Therefore, the sentence in line 7 beginning with 'In India' may be edited as follows: "In India, 7 reactors are under construction, with plans for 16 more to give 20 GWe of nuclear capacity installed by 2020. India has a very ambitious plan to nuclear power capacity and one of the reactors under construction is a prototype fast breeder reactor. India plans to expand nuclear	Noted The suggestion will be considered. However, this section is restricted to give brief reflections on nuclear programmes in various countries – not total energy programmes

						capacity based on fast reactors after the successful operation for about one year of the prototype under construction". References: Grover R B and Chandra S (2006), "Scenario for growth of electricity in India", Energy Policy, 34(2006), 2834-2847. Planning Commission (2006) Integrated Energy Policy: Report of the Expert Committee, August, New Delhi, in press. (Ravi B Grover, Department of Atomic Energy)	
4-820	A	31	7	31	9	Construction of nuclear plants in India has a poor record for timetables. Thus plans for 16 extra reactors, and even the 8 labelled "in construction" should be treated with more caution, especially with the set date of 2020. This latter date should be removed or labelled as "announced for possible installation in 2020". (ANTOINE BONDUELLE, Université Lille II)	Noted Softening of the suggested formulation will be required
4-821	A	31	11	0	0	Replace sentence "Power reactors being built today …" with "The first Generation III nuclear power plant, an EPR (European Pressurized water Reactor) is now under construction in Finland and a second EPR is planned for France. All other power reactors now under construction are Generation II designs". (David Jackson, McMaster University)	Noted Delete “third-generation”. No necessity for insisting third generation in this paragraph.
4-822	A	31	11	31	11	This statement is patently false. Of the 28 reactors 'under construction' today, precisely 1 (ONE) of them is so-called 'third generation', the reactor in Finland; which, interestingly, after 12 months of construction is already 12 months behind schedule. (Steve Sawyer, Greenpeace International)	Noted See above comment A821. The phrasing will be modified removing implicit reference to the figure 28 in page 30/line 45
4-823	A	31	11	31	16	the report asserts that "power reactors today are of safer and more economical third-generation designs." It is unclear if there is a reference for this statement; and in any event, the statement requires further substantiation - otherwise, it is mere speculation. (Steve Clemmer, Union of Concerned Scientists)	Noted Rephrasing is needed. Improved safety and economics are objectives of newly designed reactors.
4-824	A	31	11	31	16	Production costs of nuclear power included, but not construction costs. (Joanna Lewis, Pew Center on Global Climate Change)	Rejected Total costs (incl. investments) are discussed in the subsequent paragraph
4-825	A	31	11	31	12	According to industry suppliers, the cost of third generation reactors is still uncertain. Quote : "the real cost of the first EPR will be known (and only by TVO and EDF) only when all contracting is passed (…) with time, these cost will become one day public, but for the moment we have to rely on theoretical studies, based on industrial data" (B. Barre AREVA and A. Calamand Framatome ANP, 2004, "EPR : Les aspects économiques" in Revue Générale Nucléaire N 6,	Noted See response to comment A823

						December. The sentence line 11 is thus misleading for policymakers and should read : "Power reactors being built today are designed to be safer and may be more economical than second generation reactors." (ANTOINE BONDUELLE, Université Lille II)	
4-826	A	31	29	31	33	The United States has positive experience in successfully decommissioning large, pressurized water reactors and returning them to Greenfield sites. In the United States, nuclear operators are responsible for accumulating adequate funds for decommissioning either prior to or during operation. Costs for decommissioning in the United States have been on the order of USD 400 - 500 million per reactor. Check against US experience, and costs in report seem high. U.S. Government (Government of U.S. Department of State)	Taken into account This paragraph will be modified and more weight will be given to the most common (LWR) reactors and broader international information will be used (US data and NEA reviews).
4-827	A	31	30	0	0	This paragraph is quite misleading for a number of reasons. Firstly the UK Magnox reactors are different to the designs of nearly all other power reactors in the world, they are gas cooled and graphite moderated; most (about 80%) of the world's power reactors are LWRs (light water reactors). The significance of this is that Magnox reactors are very much larger and contain much more radioactive material than LWRs. A study by the NEA (Decommissioning of Nuclear Facilities, an analysis of the variability of decommissioning cost estimates; ISBN 92-64-13552-9, (Also a conference article giving a condensed overview, International Comparisons of Decommissiong Cost Estimates: Reasons for Discrepancies, J. Vira and M Yasui, Proceedings of an International Seminar , Decommissioning Policies for Nuclear Facilities, Paris,2-4 October 1991) already showed, over a decade ago, that the variation on estimated decommissioning cost could be largely explained by the volumes of radioactive material involved. In looking at the costs of decommissioning, a more recent NEA study (Decommissioning Nuclear Power Plants, policies, strategies and costs: ISBN 92-64-10431-3) showed the estimated radioactive waste volumes normalised by power output to be 10 times lower for an LWR than for a Magnox reactor. Decommissioning costs for PWRs were estimated to be around 320 USD/kWe and for BWRs at around 420 USD/kWe. This amounts to about 0.1-0.15 US cents/kWh over the lifetime of a plant; it is not a big issue. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Accepted Magnox is a minor share in the market. See also response to the previous comment A826
4-828	A	31	30	0	0	Secondly, in quoting the decommissioning costs for the Sellafield site, these are apparently attributed to the reprocessing plant. The Sellafield site has conducted a wide range of military work and research and development work over its long	Accepted See responses to comments A826 & A827

						history. Many of its most difficult (and therefore expensive) decommissioning issues are associated with these activities, not the work for the civil electricity production industry. Most of these costs should not be attributed to either the Magnox or the LWR/AGR reprocessing plants. No doubt the UK NDA can give figures for these facilities separately. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	
4-829	A	31	31	31	32	Suggest deletion of the words "plus a further £43.2 Bn for decommissioning other nuclear infrastructure including £31.5 Bn for the Sellafield reprocessing plant (NDA, 2005)" because the figure given does not relate to nuclear reactors, nor does it refer only to reprocessing plant. The £31.5bn quoted for the decommissioning of Sellafield refers to the entire Sellafield site, of which reprocessing plant represent only one component. The site also includes plant not associated with the civil nuclear industry. (Jonathan Cobb, World Nuclear Association)	Accepted A more specific, but brief, description (qualitative) will be included on special conditions in Sellafield.
4-830	A	31	31	31	32	What Bn means? Is "Billion"?. Please add in Abbreviations & Acronyms (José Somoza, National Institute of Economic Research)	Noted
4-831	A	31	32	31	33	This statement is false for the same reason as the comment directly above. Whether or not it proves to be cheaper to decommission new reactor designs will become apparent if more than one is ever built. There is ONE under construction in the world today. (Steve Sawyer, Greenpeace International)	Noted The statement will be rephrased to refer LWR reactor and not solely to EPR
4-832	A	31	35	0	0	This is not the right figure number. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Accepted Figure 4.3.17 is meant.
4-833	A	31	35	0	0	i would propose modifying the "total life-cycle GHG emissions" first sentence to add something like: "... as lower-quality ores are used, which utilize more energy in for enrichment, and depending on the enrichment process and its fuel source, nuclear GHG emissions in the future may increase to the level of natural gas fired power plants." link to analysis on this is here: http://www.opendemocracy.net/globalization-climate_change_debate/2587.jsp (Steve Clemmer, Union of Concerned Scientists)	Rejected Estimation was conducted by conventional technologies. Discussion of some additional references will be considered to be added
4-834	A	31	35	31	38	Few now dispute that the life-cycle GHG emissions from nuclear power are well below fossil fuels. However, it does not automatically follow that nuclear power is therefore “an effective GHG mitigation option”. Nuclear power exists within an overall energy supply-demand system. A system which is heavily dependent on nuclear power will be highly centralized. Such a system is unlikely to be conducive	Rejected Private opinion! The intention is not to indicate that reliance will be only on nuclear in GHG mitigation. Nuclear is one option and needs to be

						to distributed energy options especially in the developing countries. On the other hand, it is very likely to be conducive to wasteful energy consumption. Indeed, it could be argued that the underlying problem is over-consumption in the developed countries and that a desire to avoid this issue is what is fueling the recent promotion of nuclear power. Another reason why nuclear power might not be quite as effective a GHG mitigation option as the GHG emission figures suggest is that it requires back-up from fossil fuels. There are two major reasons for this. First, when there are problems with one reactor, for safety reasons it is often necessary to shut down other similar reactors. This can lead to large-scale reductions in nuclear power generation, which must be backed up from other sources. Fossil fuels are the most commonly employed replacement (for example, when Tokyo Electric Power Company was forced to shut down all its reactors in 2002). Second, for safety reasons nuclear energy is not conducive to combined heat and power. It is therefore not sufficient to simply compare GHG emissions from nuclear power with emissions from fossil fuel power plants. If combined heat and power is taken as the standard for comparison, it could be argued that the emissions from nuclear power should in fact be calculated by adding the emissions from fossil fuels used for heating to the emissions from nuclear power generation. (See: Baku Nishio, “Myth of TEPCO's Power Shortage: Tokyo can survive without nuclear power!”, Nuke Info Tokyo No. 96, July/August 2003 http://cnic.jp/english/newsletter/nit96/nit96articles/nit96tepco.html) (Kenichi Oshima, Ritsumeikan University)	employed together with other cost-rffective options (e.g. bioenergy) combined with CHP production. A balanced mix of different energy sources is needed.
4-835	A	31	36	31	37	"…….sources (see Figure 4.3.4)". Fig. 4.3.4 is about some other matter. Correct the figure number. (Government of India)	Noted Corrected
4-836	A	31	37	31	38	Suggest authors define “‘effective” and add explaination or references. U.S. Government (Government of U.S. Department of State)	Noted It is meant “cost-effective” It is obvious that upgradings without major works could be among the most cost-effective option. Reference will be provided, if possible.
4-837	A	31	40	31	44	Mention of the most carbon intensive supply option (coal) to compare nuclear with other options is misleading for policymakers. If we use this comparison, we could double this carbon figure for only (according for example, to WorldWatch Institute and UNEP 2005 and 2006, "Vital signs 2005 and 2006-2007") efficient lighting in	Noted Also average energy mix figure has already been given to avoid giving one-sided information. Alternatively the comparisons

						the world. This has no meaning. The IPCC report should avoid such propaganda arguments and thus remove this whole paragraph. The only serious way to compare option is to observe their marginal impact in the same way as other sources (e.g. in Europe the comparison should be with gas double-cycle or in Africa with hydro) (ANTOINE BONDUELLE, Université Lille II)	could be removed.
4-838	A	31	42	31	42	4 significative figures are excessive for 1,468 gTCO2/yr (is an average): use 1,5 gTCO2/yr. (Stefano Caserini, Politecnico di Milano)	Noted (undue accuracy has resulted from unit conversion in final editing)
4-839	A	31	45	0	0	This is a very strange description of why fast reactors give much better uranium utilization and it needs rewriting. Fast reactors give something of the order of 30 or more times better energy extraction per unit mass of uranium (NEA/IAEA Red Book 2005; also, OECD/NEA Advanced Nuclear Fuel Cycles and Radioactive Waste Management, ISBN 92-64-02485-9). This comes about because the 238U isotope of uranium, which is non-fissile, is converted to 239Pu, which is usable as a nuclear fuel. There must be an easy lay persons' description of this somewhere! The last sentence of the paragraph might be enough. Also, while it is true that there are continuing uncertainties in the cost as, for example, nobody has built a commercial system for partitioning and transmutation, the second OECD/NEA reference given here estimated that all the reprocessing cycles studied still produced electricity within only a 20% spread of costs. This included the current standard approaches (i.e. once through and standard reprocessing). (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Noted Text will improved. Reference is made also to Fig. 4.3.2. Furthermore, another reference to a NEA study (OECD2002, *Accelerator…and fast reactors*) with even higher efficiency of resource utilization of U.
4-840	A	31	45	31	46	Same problem. Change "next generation" to "Generation IV" (David Jackson, McMaster University)	Accepted e design objectives to be more economic an
4-841	A	31	45	31	3	the uncritical promotion of "advanced reprocessing" and fast reactors also has no reference, and completely ignores or heavily downplays the substantive technical, operational, proliferation and economic problems associated with such schemes. In particular, the comment should address the findings of the 1996 National Academy of Sciences report on "technologies for separations and transmutation" with regard to feasibility, cost and safety, as well as other expert criticisms that have been more recently expressed. (Steve Clemmer, Union of Concerned Scientists)	Noted The Gen4 plants have design objectives to be more economic, safe and proliferation-resistant. A reference needs to be added
4-842	A	31	45	32	3	This paragraph concerns fourth generation reactors which will come on line only after 2040 according for example to utility EDF (Reference : B. Dupraz EDF and L. Joudon EDF 2004 "Le développement de l'EPR dans le marché électrique	Taken into account The time period when technology will be available will be added and the "tone" revised

						européen" in La Revue Général Nucléaire N 6, December). The whole paragraph is misleading because the fourth generation is not a present policy option. To avoid contradiction with the IPCC WG III mandate to 2030, one way is to remove the whole paragraph or change the sentence to hypothesis and not the present certainty tone. The sentence should read : ... "next generation nuclear energy technology may be in a position..." and later at line 1 page 32, "can" should be replaced by "could" (ANTOINE BONDUELLE, Université Lille II)	
4-843	A	31	45	32	3	This paragraph reads as if closed fuel-cycle systems were a reality. There is no reason to assume at this early stage that optimistic closed fuel-cycle scenarios will ever actually come into being. Statements such as "fast-neutron reactors (breeder or burner), together with advanced reprocessing, partitioning and transmutation technologies, can minimize the volumes and toxicity of wastes geological disposal" and "fast-neutron reactors utilize uranium more efficiently" should be prefaced by words such as "Some people claim that …" Moreover, these claims should be treated with considerable skepticism. Note:The following articles present a few perspectives on the practicality of closed fuel-cycle systems: Steve Fetter and Frank N. vonHippel, "Is U.S. Reprocessing Worth the Risk?", Arms Control Today, September 2005, Vol. 35, No. 7. Jungmin Kang and Frank vonHippel, "Limited Proliferation-Resistance Benefits from Recycling Unseparated Transuranics and Lanthanides from Light-Water Reactor Spent Fuel", Science & Global Security, Vol. 13, No. 3, (2005), pp. 169-181. Public Citizen, "Fast Reactors: Unsafe, Uneconomical, and Unable to Resolve the Problems of Nuclear Power", March 27, 2006 http://www.citizen.org/documents/FastReactors.pdf Jenny Weil, "Industry wants government's focus on repository before recycling", NuclearFuel Vol. 31, No. 13, June 19, 2006 (Kenichi Oshima, Ritsumeikan University)	Noted See response to comment A842
4-844	A	31	46	31	36	even more sustainable…"??? A discussion of sustainability criteria would be interesting here, but is this a scientific assessment or a puff-piece for the nuclear industry? (Steve Sawyer, Greenpeace International)	Noted "Sustainable" may be changed with another word. In rephrasing one could use wording like "improve sustainability"
4-845	A	31	47	0	0	Insert after "..thorium resources." "Advanced fuel cycles are necessary to make fission power sustainable". Ref: D. Jackson, Is nuclear power environmentally	Noted Advanced will be added before "closed fuel-

						sustainable?, Int. Journal of Green Energy, 3, 1-12, 2006. (David Jackson, McMaster University)	cycle"
4-846	A	31	47	32	3	Include discussion of dangers of reprocessing? (Joanna Lewis, Pew Center on Global Climate Change)	Taken into account Need for emphasis paid on maintaining of high safety level for key nuclear facilities. These aspects could be considered to be added to section 4.3.2.2
4-847	A	32	0	32	0	Figure 4.3.2. Add "measure units" for resources (EJ, Mton, Mtoe, ?) (José Somoza, National Institute of Economic Research)	Taken into account The "measure unit" is *years of resource availability at the 2005 utilization level /see figure texty*
4-848	A	32	5	32	31	The presentation of uranium resources is misleading for policymakers, because it removes all issues about the possible competition of generations of reactors. First the figure on 4.7 Mt uranium is contradicted by official French statistics compiled by Observatoire de l'Energie and Commissariat à l'Energie Atomique in this country. (4 Mt in the case of 130 $/kg and only 2500 Mt for a cost of 80 $/kg, in L'énergie 2004, Ministère de l'Economie des Finances et de l'Industrie Paris.) Even with the figure quoted in the report this causes serious problems for reactors built after 2020 with an expected lifespan of 60 year, as expected for example of the French EPR reactor. In case of a important growth of nuclear such as proposed in part of the present report (doubling of capacity to 2030) the shortage comes way before the end of the liftime of these reactors. Thus the reserve timing of "one century" (line12) is misleading. Policymakers will have to choose earlier than 2030 between reactors not yet existing (the generation IV) and existing reactors with more risk of fuel shortage. This point is totally absent of the paragraph and make it irrelevant for a medium term policy choice. (ANTOINE BONDUELLE, Université Lille II)	Rejected Respected international publication (Red Book 2005) is relied upon here. Proven (identified) and probable (yet undiscovered) sources need to be taken into account. The exploration activities and new mines will respond to the increased demand and increased preices
4-849	A	32	6	32	20	Am I correct in assuming that all of these numbers are based upon current consumption levels? If so that is a poor basis as there is a large literature that says even in the absence of greenhouse gas emissions constraints, nuclear power is likely to expand significantly during this century. This is a particularly important point for the calculation that there are "close to a hundred years" of identified unranium if used in conventional once through reactors. If nuclear power goes through a significant expansion during this century, it is more likely that instead of "nearly 100 years" its closer to "less than 50 years". This is important as it tells	Rejected See also response to comment A848. In addition to already identified resource also probable sources need to be taken into account. The need for more efficient utilization of the energy content of uranium is clearly recognized in the text

						readers that we either need to improve mining and extraction technologies or begin to migrate to breeder reactors or nuclear power will be a declinig industry post 2050. The IPCC needs to do better than simple linear extrapolations based upon today's consumption levels. Please consult your AR4 colleagues who work with Integrated Assessment models for assistance in this regard. (James Dooley, Battelle)	
4-850	A	32	8	32	9	**Don't think this is needed. Because it refers to energy content, not that that could be extracted** "In the long term, the potential of nuclear power is dependent upon the uranium resources available. Extraction is relatively straightforward since the energy contained in uranium is 1 million times more concentrated than that in fossil fuels." This text should be clarified to specify the 1 million times refers to the theorectical total energy content or that that could be utilised in a fast breeder reactor. Also, does the energy content of the uranium have any relevance to the ease of extraction. (Jonathan Cobb, World Nuclear Association)	Noted The sentence “Extraction is …..fossil fuels# will be removed.
4-851	A	32	11	32	12	Maybe explain how nuclear primary energy is defined. The norm I think is to compute it as 3 times the amount of electricity produced, so that it is consistent with what used to be the typical efficiency in fossil power plants. (Danny Harvey, University of Toronto)	Noted Standard IEA practice is followed and a conversion efficiency of 33% for nuclear is taken into account.
4-852	A	32	16	32	20	It states here that thorium-based thermal fast reactor technology remains undeveloped. A similar qualification should be added for ‘fast reactors operated in a “closed” fuel cycle’. Development has been continuing for over 50 years, but technical, safety and cost issues remain unsolved. (Kenichi Oshima, Ritsumeikan University)	Rejected Fast reactor (Superphenix) has been in commercial operation in France and large reactor are in operation in Beloyarsk. Broadening the technology development. needs will be considered in rephrasing.
4-853	A	32	19	32	27	The sentence beginning with 'Thorium-based reactors', in the line 19, needs editing and repositioning. This needs to be placed after the sentence ending with 'less than uranium' in the line 27. The sentence should read as follows, "Thorium-based reactors appear capable of at least doubling the effective resource base and necessary technologies are being developed only in India." (Ravi B Grover, Department of Atomic Energy)	Accepted
4-854	A	32	19	32	19	Table 4.3.2 not 4.3.1 (Government of France)	Rejected Table 4.3.2 does not include the pertinent information. Reference will be instead to

							Fig. 4.3.2
4-855	A	32	19	32	19	Delete "fast" (Government of France)	Noted "thermal fast" will be replaced by "thermal breeder"
4-856	A	32	19	32	0	Clarify whether "thermal fast reactor" refers to thermal power plants using fast reactors or some other scenario. Generally reactors cannot be both "thermal" and "fast". U.S. Government (Government of U.S. Department of State)	Noted see above comment A855
4-857	A	32	20	0	0	Where is table 4.3.1? I think this has become figure 4.3.2. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Noted Table 4.3.1 is on page 23. Reference to Fig. 4.3.2 needs to be added
4-858	A	32	20	32	25	Figure 4.3.2 consider rounding some of these numbers. "15,400" and "119,000 years" seem like overly precise estimates. Are there really three significant digits in these estimates? (James Dooley, Battelle)	Accepted It is enough of two digits in the estimate.
4-859	A	32	21	32	25	Figure 4.3.2, do you mean RP ratio? (Junichi Fujino, NIES)	Noted RP ratio is not usually employed for uranium resources. Here the unit is explained in the figure caption. (Estimated years… at 2005 utilization level)
4-860	A	32	23	0	0	After "availability" add "and identified resources (EJ of primary energy)" (Danny Harvey, University of Toronto)	Rejected The suggested addition is not compatible with the quantity displayed in the diagram
4-861	A	32	23	0	0	Figure 4.3.2. The comments on Figure 4.3.2 also apply to Figures 4.2.1 and 4.4.2 and to Tables 4.3.1 and 4.4.2. Even to an experienced reader it's completely unclear how Figure 4.3.2 has been derived from the data in the Red Book 2006. It's unclear either why the figures in this draft version are so much higher than in the First Draft, for they are based on theoretical assumptions. Apparently the high resource figures in the quoted Tables and Figures are based on a flawlessly operating breeder system and an unlimited availability of fissile plutonium and uranium-233 (for the thorium breeder). These assumptions all are a far cry from reality. Furthermore the authors ignore the energy consumption of the nuclear chain and, more important the energy consumption of the extraction of uranium from uranium-bearing rocks. So the authors ignore the relationship between net energy from nuclear power and the	Noted Additional reference will be added to explain the uppermost bar in each set. Otherwise RedBook 2005 table is only converted into a diagram. Thorium breeder is not taken into account. A reference to work of the commentor was removed in the final edition. The reference will be readded to the final version.

						grade of uranium ore. The existence of the 'energy cliff' excludes all uranium-bearing deposits with grades lower than 0.02% U3O8 from the energy resources. The scientific basis of my comments are on the website www.stoermsmith.nl Some are underpinned in attached Appendix. (Jan Willem Storm van Leeuwen, Ceedata Consultants)	
4-862	A	32	23	0	0	Figure 4.3.2 We can not found the data of "Pure fast reactor fuel cycle with recycling of U and all actinides" in Table 27 of "Red Book 2005". Description is required. (Government of Japan)	Noted The text explaining this will be added again as well as a reference to another NEA study
4-863	A	32	24	32	25	An explicit explanation should complement the reference to the Red book, not available to most readers (Government of France)	Accepted See response to comment A863
4-864	A	32	26	32	30	Please indicate why India's case is different (Ajay Guha, Asian Development Bank)	Noted Only in India, thorium is used as nuclear fuel, because most abundant thorium resources are in India.
4-865	A	32	30	0	0	Who claims it to be more proliferation resistant? The implication here is that somebody is being deceptive; who is this somebody to whom this accusation is leveled? (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Taken into account Wording will be modified; for example "… produces fissionable U-233 of high level radioactive element that might be more proliferation-resistant than other fuel cycles."
4-866	A	32	30	0	0	The implication of "which, although claimed to be more proliferation resistant.. U-233." implies that weapons can be made from U-233 which would be very difficult if not impossible. The phrase in quotes should be removed. (David Jackson, McMaster University)	Noted The sentence will be modified; see response to comment A866
4-867	A	33	7	33	8	Protective actions for mill tailing piles have been demonstrated and should be applied to make sure radon emissions are not harmful. U.S. Government (Government of U.S. Department of State)	Noted The demonstration aspect will be added.
4-868	A	33	8	0	0	Change "piles" to "piles and ponds" (David Jackson, McMaster University)	Noted
4-869	A	33	10	0	0	Some of this is not quite accurate. Also, these liability arrangements are often misunderstood. The advice offered here was provided by OECD/NEA Legal Division. The OECD is the depository for the Paris Convention: (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Taken into account The advice given in subsequent comments will be utilized (in shortened form)

4-870	A	33	10	0	0	iv) The U.S. situation should be clarified. Funds to compensate victims of a nuclear accident are provided through a two tier system: the first tier is USD 300 million (not 200 million as stated) and consists of the proceeds of insurance which each operator must maintain for its installations; the second tier comprises operator imposed assessments of USD 95.8 million per installation/accident + 5% for claims/costs to be paid in the event of an accident. With 104 NPP's in operation, the two tiers total about USD 10.4 billion. Second tier payments are guaranteed by the U.S. Government. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Noted Key issues will be included
4-871	A	33	10	0	0	iii) Certainly not ALL non-OECD countries have similar arrangements through the IAEA's Vienna Convention. China, India, Pakistan, South Africa, and Taiwan all have NPP's and are all members of the IAEA but none of them are party to the Vienna Convention. (Membership status info is available on the IAEA website). (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Noted Word “some” is added before “non-OECD”
4-872	A	33	10	0	0	ii) In 2004, the Contracting Parties to both the Paris and Brussels Supplementary Conventions adopted amending Protocols which will result in 1500 million euros of compensation being available for third party damage under that combined regime. It is not correct to say that the liability limit is set at 1500 million euros. Under Article 7 of the revised Paris Convention, the minimum liability limit for nuclear operators will indeed be fixed at not less than 700 million euros but under Article 3 of the revised Brussels Supplementary Convention (which does not set liability limits but provides for the availability of additional compensation), additional compensation of up to 800 million euros will be made available through public funds. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Noted More factual, but still brief; description will replace the present formulation.
4-873	A	33	10	0	0	i) It would be better to say that we know that operators of NPP's in MOST countries are liable, without proof of fault or negligence, for damage suffered by third parties as a result of an incident occurring at their installations. There are, however, a few countries where we do not know if that is the situation (e.g. India and Pakistan), so it is probably better not to generalise here. The Conventions recognise that the public's need of protection against the usual nature of nuclear risks needs to be balanced by the industry's need of protection against potentially debilitating liability claims. The resulting compromise imposes both strict and exclusive liability for third party damage on nuclear operators while ensuring that both a reasonable ceiling is imposed on the amount of that liability and the time period	Noted This restriction to “most countries” will be added

						within which it is imposed. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	
4-874	A	33	10	33	17	The subject clause of this paragraph is belied both by the rest of the paragraph and by reality - it describes precisely how operators of nuclear power plants are NOT liable for damage, or rather the limits to that liability - and how the rest of the liability is assumed by the state on their behalf. If states did not assume this liability, no private operator would be able to operate a nuclear power plant. This state responsibility for nuclear power generally extends to decommissioning as well as long term waste storage; not to mention about close to 50% of IEA member government RD3 budgets in the energy sector over the last 35 years as cited on p 96 of this draft (IEA 2004b)and again in Figure 1.9 of Chapter 1 of this draft (IEA 2006). (Steve Sawyer, Greenpeace International)	Noted The formulation will revised of an operator in the revised Paris-Brussels conventions The decommissioning and waste management and disposal fund arrangement are existing for most of EU-countries having NPPs and also in other countries, such as in Japan
4-875	A	33	10	0	0	insert "partially" before "liable for any damage caused by them to third parties..." (Steve Clemmer, Union of Concerned Scientists)	Noted The word “any” will be deleted
4-876	A	33	19	0	0	Section 4.3.2.3. This section may make the scale of the issue seem much larger that it really is. Although I accept it that it is commonly presented as a big problem, the purpose of this IPCC document is to ensure that governments are as well informed as possible. The volume of HLW from the Nuclear Fuel Cycle is quite limited in comparison to other toxic waste produced by modern societies and it has been demonstrated that these type of waste can be stored safely for extended time periods. Moreover, some countries recognise the value of spent nuclear fuel as a future energy resource (after reprocessing) and decided to store spent fuel for extended periods. There is a consensus among the engaged technical community that engineered geologic disposal provides a safe and ethical method for the long-term management of high-level radioactive waste (The Environmental and Ethical Basis of Geologic Disposal: A Collective Opinion of the NEA Radioactive Waste Management Committee, Nuclear Energy Agency of the OECD, Paris, 1995) and a wide technical consensus exists that the technology for constructing and operating repositories is mature enough for deployment (Progress Towards Geologic Disposal of Radioactive Waste: Where Do We Stand?; Nuclear Energy Agency of the OECD, Paris 1999). Moreover, geologic disposal of HLW, albeit not from nuclear power plants, has been routinely performed at the WIPP disposal facility in New Mexico, USA, since 1999. In many countries underground research laboratories for local rock studies are in operation or under construction at sites foreseen for	Noted Within the text space available it is difficult to give a more convincing ensurance that waste management and disposal is not any more as big issue as before owing to significant recent progress: especially in Nordic countries. The Waste Isolation Pilot Plant (WIPP) deep geological repository for transuranium containing defense wastes can be mentioned (together with a reference)

						geologic repositories, and the Finnish repository is in the process of construction already (see the UK Committee on Radioactive Waste Management report, "Managing Our Radioactive Waste Safely, chapter 15, p116). (Stanley Gordelier, Nuclear Energy Agency of the OECD)	
4-877	A	33	29	33	31	The sentence does not represent adequately the actual legal situation in Finland and should be changed. The legal text referred from line 29 is « Valtioneuvoston periaatepäätös 21 päivänä joulukuuta 2000 Posiva Oy:n hakemukseen Suomessa tuotetun käytetyn ydinpolttoaineen loppusijoituslaitoksen rakentamisesta », available at http://www.stuk.fi/ydinturvallisuus/ydinjatteet/loppusijoitus_suomessa/fi_FI/luvat/ An unoffical translation by the Finnish Radiation and Nuclear Security Authority is titled "The decision in principle by the Government on 21December 2000 concerning Posiva Oy's application for the construction of a final disposal facility for spent nuclear fuel produced in Finland" and available on http://www.stuk.fi/ydinturvallisuus/ydinjatteet/loppusijoitus_suomessa/en_GB/luvat/ This text explains that "the project can progress to the construction of underground research facilities and detailed site characterisation". So the company seeking to bury HLW in Finland will need a construction permit and an operation permit before actual disposal of nuclear waste can take place. The government has granted a permit for underground research at the site and said that "if the conditions for those permits are fulfilled, building a repository "is in the overall interest of society". The present text does not adequately reflect this. Another quote of the same text passed in Finnish Parliament is: "The decisions of the Government on the granting of a licence (34/814/82) in 1983 concerning continuation of the operation of Teollisuuden Voima Oy's nuclear power plant units, which include a regulation to make provision for final disposal in Finland, which fulfils the safety and environmental protection requirements, with the design basis of being able to begin the final disposal in about 2020." So the government has not made a commitment to have this specific site in operation but to have A repository by 2020. A proposed change (page 33 line 29) as a compromise :"In 2001, the Finnish Parliament ratified the Government's decision concerning a spent fuel repository in the vicinity of the Olkiluoto nuclear power plant, granting permission for an underground research facility. After detailed rock characterisation studies, the company can apply for a construction permit for the site. Finland is aiming to start construction of a repository soon after 2010 for use around 2020."	Taken into account In the final editing of the SOD version the editor removed the atribute « in principle » after decision. The required construction and operating licences will be mentioned as well.

						(ANTOINE BONDUELLE, Université Lille II)	
4-878	A	33	37	0	0	In the French example, the date of 2025 is misleading because the Senate and Assembly votes mention the horizon 2025 with reserves such as validation of the scientific work; that storage should be reversible and does not include a mandatory date to open a possible repository. ("Projet de loi de programme relatif à la gestion durable des matières et des déchets radioactifs du 15 juin 2006", 2006, N 590, Assemblée Nationale, France.) The sentence should read "the goal of the deep burial construction in France is set at 2025, and this storage should be reversible". (ANTOINE BONDUELLE, Université Lille II)	Accepted
4-879	A	33	37	0	0	The reference to France is not factual : the last legislative text in the French Parliament still put the reversible deep underground storage with other optionssuch as than sub-surface storage and transmutation of actinides in special reactors."Projet de loi de programme relatif à la gestion durable des matières et des déchets radioactifs, 2e lecture par l'Assemblée nationale le 15 juin 2006", 2006, N 590, Assemblé Nationale, France (ANTOINE BONDUELLE, Université Lille II)	Noted In the case of France three « support legs » are still needed and studied: a) interim storage, b) transmutation, c)c) deep geological disposal. It is important that geological disposal is required and a) and b) are not sufficient.
4-880	A	33	39	33	40	The statement “Reprocessing and reuse of spent nuclear fuel further reduces the volume and radionuclide inventory of HLW” is misleading. Reprocessing does not reduce the total radionuclide inventory. It only separates it into various streams. The total volume of radioactive waste actually increases. The volume in the stream labeled HLW is slightly reduced, but other streams increase and more radioactivity is released into the environment. A genuine reduction in volume and radionuclide inventory might occur if theoretical “fast burner” reactors prove to be feasible, but even optimists recognize that it will be decades before these come on line. In fact, there is no guarantee that these reactors will ever be technically or economically viable. Ideally, this statement should be completely deleted. However, if the statement is retained, it should be rewritten with the following qualification: “Proponents of reprocessing and reuse of spent nuclear fuel claim that…” The statement should then be followed by an acknowledgement of the uncertainties involved. See: Steve Fetter and Frank N. vonHippel, “Is U.S. Reprocessing Worth the Risk?”, Arms Control Today, September 2005, Vol. 35, No. 7. (Kenichi Oshima, Ritsumeikan University)	Rejected The sentence will be clarified to include advanced separation (partitioning); closed fuel cycle; use of fast reactors plus reference to section 4.3.2.1
4-881	A	34	5	0	0	Section 4.3.2.4. I suggest a little reordering of the words and some changes to the text here as follows: "Present designs of reactors are classed as Generations I	Accepted Repositioning of the PBMR text is OK.

						through III (Figure 4.3.3) whereas Generation III+ advanced reactors are now being planned and aim to be in operation during 2010 - 2020 (GIF, 2002). These plants include evolutionary reactor designs with improved economics, simpler safety systems and impacts of severe accidents limited to the close vicinity of the reactor site. They are likely to become state-of-the-art nearer 2020 to meet possible increased demand, an example being the European pressurized water reactor (EPR) now under construction and scheduled to be in operation in Finland around 2010 and the Flamanville plant planned in France. There is also an ongoing development project by the South African utility ESKOM for an innovative high temperature, pebble bed modular reactor (PBMR). Specific features include its smaller unit size, modularity, improved safety by use of passive features, lower power production costs and the direct gas cycle design utilizing the Brayton cycle (Koster et al., 2003; NER, 2004). Generation-IV designs are being pursued by the Generation-IV International Forum (GIF, a group of ten nations plus the Euratom.). GIF has established a framework for international collaboration to foster and facilitate the development of Generation IV Systems that can be licensed, constructed, and operated in a manner that will provide competitively priced and reliable supply of energy while satisfactorily addressing nuclear safety, waste, proliferation and public perception concerns (ref. GIF Framework Agreement). Also, the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), coordinated by the IAEA, aims at supporting the safe, sustainable, economic and proliferation-resistant use of nuclear technology to meet the global energy needs of the 21st century (ref. IAEA web site). Much additional technology development is needed to meet these long-term goals. In its first phase (2002), GIF developed a technology road map and selected six systems found to be the most promising: the Gas-Cooled Fast Reactor System, the Lead-Cooled Fast Reactor System, the Molten Salt Reactor System, the Sodium-Cooled Fast Reactor System, the Supercritical water-Cooled reactor System and the Very High Temperature Reactor System. Nuclear electricity could be used to produce hydrogen from an essentially carbon free primary energy source by electrolysis. Reactor concepts capable of producing high temperature heat (e.g. the GIF Very High Temperature Reactor) could be used to produce hydrogen directly by thermo-chemical water splitting. In summary, the experience of the past three decades has shown that nuclear power	However, additional detail are not compatible with the stringent overall text space restriction. Possibilities to briefly amend parts of the text will be considered.

						can be very beneficial if employed correctly, but can cause significant problems if appropriate standards are not met. It shows very substantial potential for an expanded role, but it is currently a technology best suited to developed nations. While the economics of nuclear generation do not seem to be an issue (Projected Costs of Generating Electricity, 2005 update; IEA/NEA, ISBN92-643-0082-8) there continue to be public and political concerns with respect to potential accidents, waste disposal and the possible proliferation of nuclear weapons technologies. This wording uses GIF and INPRO directly to describe the scopes. It also reflects the recent IEA/NEA report which found that the levelised cost of nuclear generation is comparable with or better than that from other sources (IEA/NEA; Projected Costs of Generating Electricity – 2005 update). This source is quoted elsewhere in this IPCC report." (Stanley Gordelier, Nuclear Energy Agency of the OECD)	
4-882	A	34	5	0	0	Section 4.3.2.4 requires updating to reflect the latest incarnation of DOE's Generation IV program, which is now known as GNEP and is based entirely on development of sodium-cooled fast reactors. (Steve Clemmer, Union of Concerned Scientists)	Rejected GNEP is an additional initiative and it is not replacing the GIF. GNEP will be considered to be mentioned elsewhere.
4-883	A	34	13	0	0	The EPR is in fact the first of the Generation III reactors. (David Jackson, McMaster University)	Noted
4-884	A	34	20	34	28	The last sentence in this paragraph acknowledges some of the uncertainties, but the second sentence should be reworded as follows: “These initiatives focus on the development of reactors and fuel cycles that are hoped to provide economically competitive, safe and environmentally sound energy services based on technology designs that exclude severe accidents, involve proliferation resistant fuel cycles decoupled from any fuel resource constraints, and minimize HLW. (Kenichi Oshima, Ritsumeikan University)	Noted The sentence will be slightly revised to make it less certain.
4-885	A	34	26	0	0	What do you mean by “decoupled from any fuel resource constraints”. Sounds like the supply is infinite. (Danny Harvey, University of Toronto)	Noted
4-886	A	34	26	34	28	Suggest editing sentence to read: “…since there is limited industrial/commercial interest at this stage”. U.S. Government (Government of U.S. Department of State)	Noted

4-887	A	35	0	55	0	Chapter 4.3: Discussion on technical potentials is very brief or absent, despite that is the supposed focus of the chapter. The TAR treatment was better. The little information there is is rarely translated into anything that helps assess the mitigation potential of (new) renewables. Table 4.4.2 in a later chapter includes some estimates of technical potentials to 2050, but why not include that in 4.3, along with a more in depth treatment? Or some of the material in the 2001 World Energy Assessment on technical potentials. (Donald Pols, Friends of the Earth Netherlands/Milieudefensie)	Rejected It is not appropriate to transfer Table 4.4.2 to Ch 4.3
4-888	A	35	11	35	12	Nuclear power can be utilized to supply hydrogen (ANS 2001 et.al.) not only by electrilysis but steam reforming heat supplier. Direct heat-chemical process will be applicable with HTGR. Potential utilization other than electroc power generation should be here touched upon. (Shunsuke Mori, Tokyo University of Science)	Noted Hydrogen production and steam reforming is already mentioned on page 35; lines 4-5.
4-889	A	35	13	35	18	I recommend deleting this paragraph, or else qualifying it. For example the rating agency Standard & Poors in November 1995, published a report containing analysts' commentary (focused on the EU), a section titled 'EU Nuclear Power Shows Signs of Surging Back, But its No Renaissance" - while acknowledging there is strong renewed interest, it says 'significant hurdles remain for large-scale nuclear investment", it goes on to outline some of those from an investment perspective. Standard & Poors 'Infrastructure Finance Ratings Climate Change Credit Survey, a Study of Emissions Trading, Nuclear Power, and Renewable Energy." November 2005. (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	Rejected Paragraph is balanced and includes also discussion of uncertainties and problem areas.
4-890	A	35	13	35	18	Is it appropriate to insert "Perhaps the biggest problem surrounding nuclear power is convincing people that we need it, requiring a complex argument involving lots of numbers about energy needs and projections for the realistic potential of other carbon-free sources over the next 50 years."? (James Boyden, Vulcan Inc.)	Rejected This suggestion is too controversial to be included in the text.
4-891	A	35	13	35	18	The public acceptance problem should be mentionned, possibly with a reference to the successful Finnish experience (Government of France)	Noted Gradually improving public acceptance could be mentioned within this subsection.
4-892	A	35	15	35	15	The text states that nuclear must be "improved economically". However, many studies show that nuclear generation is amongst the lowest cost forms of generation e.g."The Costs of Generating Electricity, p4, The Royal Academy of Engineering http://www.nowap.co.uk/docs/generation_costs_report.pdf". Whilst the industry is	Noted Recent developments (incl. emission trading) has removed to large extent this obstacle. The sentence is considered to be deleted,

						engaged in increasing efficiency, further cost reductions are not a requirement for additional deployment of nuclear power. This is consistent with the evidence presented in Figure 4.4.3 on page 77 of Chapter 4 in this draft. Suggest deletion of "but must be improved economically and in terms of its ease of use" (Jonathan Cobb, World Nuclear Association)	
4-893	A	35	15	35	18	There is no scientific or political basis for the claim at the end of the following sentence: "The problems of potential reactor accidents, nuclear waste management and disposal, and nuclear weapon proliferation will remain as constraints that can likely be managed successfully with continued vigor." It should therefore be reworded as follows: "The problems of potential reactor accidents, nuclear waste management and disposal, and nuclear weapon proliferation will remain. It is unclear whether these constraints can be managed successfully." Note: The following articles present a few perspectives on the practicality of closed fuel-cycle systems: Steve Fetter and Frank N. vonHippel, "Is U.S. Reprocessing Worth the Risk?", Arms Control Today, September 2005, Vol. 35, No. 7. Jungmin Kang and Frank vonHippel, "Limited Proliferation-Resistance Benefits from Recycling Unseparated Transuranics and Lanthanides from Light-Water Reactor Spent Fuel", Science & Global Security, Vol. 13, No. 3, (2005), pp. 169-181. Public Citizen, "Fast Reactors: Unsafe, Uneconomical, and Unable to Resolve the Problems of Nuclear Power", March 27, 2006 http://www.citizen.org/documents/FastReactors.pdf Jenny Weil, "Industry wants government's focus on repository before recycling", NuclearFuel Vol. 31, No. 13, June 19, 2006 (Kenichi Oshima, Ritsumeikan University)	Rejected Progress in these respects could be supported by practical examples, but the text space available does not allow a detailed discussion.
4-894	A	35	15	35	15	Change "improved economically" to "demonstrated to be economic". U.S. Government (Government of U.S. Department of State)	Noted See response to comment A892.
4-895	A	35	17	35	18	Insert 'and public opposition' after 'proliferation' and delete 'that can likely be managed successfully with continued vigor'. (Government of Spain)	Rejected See response to comment A891. Another insertion place than suggested will be considered.

4-896	A	35	20	35	30	This section on fusion is essentially correct and up to date, and the references are appropriate. However, given the now well-advanced state of fusion development, the great abundance of fusion's fuels, its well-authenticated major safety and environmental advantages, and the well-supported projections of viable economics, a longer section is mandated. Appropriate amendments and additions to this sub-section are supplied in line-by line comments in separate cells by this reviewer. (Ian Cook, United Kingdom Atomic Energy Authority)	Noted
4-897	A	35	20	0	0	Given the maturity of the world fusion development program, the environmental advantages of fusion power, and the great abundance of fusion fuel, more description should be provided. See attachment Goldston.doc (Robert Goldston, Princeton Plasma Physics Laboratory)	Noted Text space allocation to Nuclear-section does not allow substantial addition.
4-898	A	35	20	35	39	Suggest replace text with: Fusion is a very attractive, long-term form of nuclear energy. In the fusion process two isotopes of hydrogen, deuterium and tritium, are maintained at very high temperature (100M C) so that they collide at high velocity and fuse, producing energetic helium nuclei and neutrons. The helium nuclei can be used to sustain the high fuel temperature, while the neutrons are captured in lithium to regenerate tritium, which does not exist in nature. The basic fuels for fusion, deuterium and lithium, are abundant. Deuterium is easily extracted from sea or fresh water, and is essentially unlimited. Lithium reserves on land are estimated at 11 Mt in known ore deposits, corresponding to 300,000 EJ of primary energy production, while 200 Bt of lithium should be economically extractible from seawater. There is no possibility of a runaway reaction or of a meltdown in a fusion system, because only tens of seconds of fuel is present at high temperature, and there is no significant radioactive afterheat problem. Radioactive waste from fusion systems decays to activity levels similar to that of the radioactivity in the waste from equivalent coal-fired power plants after a time period in the range of 100 years. The waste requires only shallow land burial, not geological storage. The projected cost of electricity from fusion is estimated at 5 – 10¢/kWh. There is very limited risk of nuclear weapons proliferation from fusion. Neutrons are produced by the fusion reaction, which could in principle be used to transmute fertile materials for use in weapons. However there is no need for any such materials to be present in a fusion system, and they are easily detectable. Clandestine operation of a fusion power system is not a credible risk.	Noted See above response to comment A897. The suggested replacement text is too detailed and voluminous.

						Construction of ITER, a 500 MW(th) fusion device, is now beginning in France as a collaboration of China, the European Union, India, Japan, Russia, South Korea, and the United States, (see www.iter.org). ITER will demonstrate the scientific and technological feasibility of fusion energy. In addition to ITER, research and development is proceeding on optimized configurations and materials for the fusion environment, and on qualification of large-scale components for fusion power plants. Plans under consideration by a number of the ITER partners call for demonstration power plants in the time frame of 2035, allowing the commercialization of fusion by 2050. With a market penetration rate of 0.4%/year of total energy production, as experienced by fission world-wide in the period 1975 – 1985, fusion could provide over 200 EJ/year of primary energy by 2100, and much more in the next century. U.S. Government (Government of U.S. Department of State)	
4-899	A	35	21	35	29	Here a reference has been made to the project ITER. This project is very significant because it is the first such project where the Parties participating represent more than half the world's population. Therefore, in the line 25, after the sentence ending with 'temperature', the following sentence may please be added. "Seven Parties viz. EU, China, Japan, India, Russian Federation, South Korea and the USA, are participating in the ITER venture. These parties together represent more than half the world's population and this fact is svery significant from the point of future energy security for the world." (Ravi B Grover, Department of Atomic Energy)	Noted The first first suggested sentence can be added
4-900	A	35	21	35	30	On fusion : innocuity of the process of a fusion reactor is not even is uncertain, but is considered to be a major impediment to the development of the technique, in particular with materials surrounding the reactors. Mention should be made of "disposal of irradiated material is also still an issue." (ANTOINE BONDUELLE, Université Lille II)	Rejected Need for additional technology development is already clearly indicated.
4-901	A	35	21	35	30	On fusion : Innocuity of the process of a fusion reactor not even is uncertain, but is considered to be a major impediment to the development of the technique, in particular with materials surrounding the reactors. Mention should be made of "disposal of irradiated material is also still an issue." (ANTOINE BONDUELLE, Université Lille II)	Duplicate comment
4-902	A	35	22	35	30	The paragraph on fusion is OK but an additional sentence should be inserted at the end to point out the relationship between advanced fission and fusion. "A successful ITER would re-orient the emphasis in advanced nuclear power from	Rejected So clear cut success is not likely, Therefore both advanced nuclear fission and fusion need

						fission to fusion; similarly, a failure of ITER would have the opposite effect." (David Jackson, McMaster University)	to be developed further.
4-903	A	35	22	35	30	Is it appropriate to insert "A major issue with the ITER program is that it is so expensive that it is absorbing more than 90% of the funding for fusion research on alternative concepts, some of which could lead to burning aneutronic fuels and might achieve success sooner than a demonstration of a commercial power plant based on ITER."? (James Boyden, Vulcan Inc.)	Rejected Controversial issue
4-904	A	35	23	35	23	After 'energy', insert: '(deuterium is readily and cheaply obtained from water and the intermediate fuel, tritium, is generated within the power plant from the basic fuel, lithium, which is abundant). Remarkably, the lithium in one laptop battery, plus the deuterium from half a bath-full of water, would generate the per capita electricity consumption of a West European country for thirty years! (Ian Cook, United Kingdom Atomic Energy Authority)	Noted Possibility to add this type of text can be considered.
4-905	A	35	23	35	24	add the reference http://www.iter.org/ in the references chapter (page 111) (Stefano Caserini, Politecnico di Milano)	Noted
4-906	A	35	23	35	23	"……ITER,…". Write full form of ITER (Government of India)	Accepted
4-907	A	35	24	35	25	Delete 'demonstrate……..temperatures' and replace by: 'construct a 500MW fusion device in France.' (Ian Cook, United Kingdom Atomic Energy Authority)	Noted
4-908	A	35	28	35	30	On fusion : The mandate of the chapter (mitigation before 2030) excludes the consideration of fusion as a mitigation option. So a fair presentation would be i) delete the whole paragraph or ii) add a reference to "the large proportion of resources invested by participants of fusion experiments, with no prospects of any energy production in time for any significant mitigation under the UNFCCC" (to avoid dangerous interference with the climate) (ANTOINE BONDUELLE, Université Lille II)	Rejected Mitigation options beyond 2030 need still to be developed. The mandate should not be interpreted too literally. The problem of GHG emission mitigation is not solved by 2030.
4-909	A	35	28	35	30	On fusion : The two sources at the end of the paragraph on the time horizon for fusion are misquoted or biased in the mention of "commercial viability". Other sources pro or anti fusion all mention the "demonstration of technical feasability" as the horizon and never acknowledge any prospect for economic viability. For example, Percebois J. 2003 "The peaceful uses of nuclear energy: future perspectives and risk management", Energy Policy, vol.31, January. Thus the sentence should be "Although controversial, the technical feasability has been	Rejected See comment A896 as a motivation not to accept the suggestion

						contemplated for after 2050, assuming successful initial demonstration". (ANTOINE BONDUELLE, Université Lille II)	
4-910	A	35	28	35	30	On fusion : The two sources at the end of the paragraph on the time horizon for fusion are misquoted or biased in the mention of "commercial viability". Other sources pro or anti fusion all mention the "demonstration of technical feasability" as the horizon and never acknowledge any prospect for economic viability. For example, Percebois J. 2003 "The peaceful uses of nuclear energy: future perspectives and risk management", Energy Policy, vol.31, January. Thus the sentence should be "Although controversial, the technical feasability has been contemplated for after 2050, assuming successful initial demonstration". (ANTOINE BONDUELLE, Université Lille II)	Rejected Duplicate of comment A809
4-911	A	35	28	35	28	"Commercialization of ….". Delete 'Commercialization of' and start the sentence from "Fusion power" (Government of India)	Accepted
4-912	A	35	28	35	29	"Commererically" (typo) repeats the "commerzialisation" in the preceeding line. More important, if a technical prototype may be available in 2050, a commercial plant will likely not. (Government of France)	Taken into account
4-913	A	35	30	35	30	After (2005)', insert: 'Extensive studies [W,X,Y,Z] have shown that the projected range of cost of electricity from fusion is 5-10cents/kWh(e), that the worst possible accident would be very limited and that there would be no need for long-term geological storage of waste. These advantages will be valuable in securing social acceptance.' References: [W] D.J. Ward, I. Cook, Y. Lechon, R.Saez, "The Economic Viability of Fusion Power", Fusion Engineering and Design 75-79 (2005) 1221-1227. [X] D Maisonnier, I Cook, P Sardain, R Andreani, L Di Pace, R Forrest, L Giancarli, S Hermsmeyer, P Norajitra, N Taylor, D Ward, "A Conceptual Study of Commercial Fusion Power Plants: Final Report of the European Power Plant Conceptual Study". European Fusion Development Agreement (EFDA) Report EFDA-RP-RE-5.0, April 2005. [Y] I. Cook, D. Maisonnier, N.P. Taylor, D.J. Ward, P. Sardain, L. Di Pace, L. Giancarli, S. Hermsmeyer, P. Norajitra and R. Forrest, "European Fusion Power Plant Studies", Fusion Science and Technology 47, 384, April 2005. [Z] F. Najmabadi et al., 'ARIES-AT: an Advanced Tokamak, Advanced Technology, Fusion Power Plant', 18th IAEA Fusion Energy Conference, Sorrento, Oct. 2000. (Ian Cook, United Kingdom Atomic Energy Authority)	Noted Possibility (availability of text space) can be examined to include this suggestion.

4-914	A	35	30	35	30	After '2005).', insert: 'Given the now well-advanced state of fusion development, the great abundance of fusion's fuels, its well-authenticated major safety and environmental advantages, and the well-supported projections of viable economics, the full inclusion of fusion in future ipcc scenario studies is now clearly needed. Self-consistent energy/environment/economic scenario modelling studies [P,Q], incorporating fusion power, have already been performed to 2100 using well-established codes such as MARKAL, and preparatory studies for more extensive modelling, using the code TIMES, are well advanced. References: [P] P. Lako, J.R. Ybema and A.J. Seebregts, "The Long-Term Potential of Fusion Power in Western Europe", ECN-C-98-071, 1998. [Q] K. Tokimatsu et al., "Studies of Breakeven Prices and Electricity Supply Potentials of Nuclear Fusion by a Long-Term World Energy and Environmental Model", Nuclear Fusion 42 (2002) 1289. (,)	Rejected Goes too much into the details

Comments on section 4.3.3 (except Biomass &wind) Julio/Inga

4-915	A	35	31	56	21	Section 4.3.3 Renewable Energy. As well you use as energy unit the EJ, clarifying sometime their equivalence in other energy units, could not make the same thing with the prices or cost of the energy?, this is, to use a basic unit, the US Dollar or the Euro, and anyway to present the equivalence. For example, in the figure 4.3.4 (page 37), the costs are presented in USD/kW, while in the figure 4.3.5 (page 40), and the corresponding text to the section 4.3.3.2 "Wind" (page 39), is used the euro like monetary unit to measure costs. (José Somoza, National Institute of Economic Research)	Accepted
4-916	A	35	34	0	0	A comment on the methodology to calculate the energy provided from renewables would be insightful for non-insiders (see also my comment to line 35 below). Maybe it would be best to give two values for the energy from renewables either i) applying the 'heat from electricity'-method ['Heizwertmethode' in German] and ii) the substitution method ('quantify the primary energy as if the electricity were produced in fossil power plants'). (Manfred Treber, Germanwatch)	Accepted – it is better to employ the substitution method, in order to address the quantity of fossils that could be saved.
4-917	A	35	35	0	0	It seems to be a problem of statistics but it is more. How to quantify the 'energy content' of electricity produced from renewables? In line 35 we read that energy accounted for large hydro is 6 % (please give the number of TWh produced in 2004 from large hydro!!) because it is calculated if you take the heating value of the electricity. If you calculate the electricity from renewables as if the electricity were produced in a fossil power plant (a take the primary energy needed for this) you get roughly three times more energy from renewables, i.e. no 6 % from large hydro but 18 % [I did not adjust that then the whole 100% is 112% or so]. If you compare with the energy from nuclear ('16–17% of the world total' on page 30, line 33) you see that in your logic the large hydro produces roughly the same electricity that nuclear energy (therefore please give the data on electricity produced from large hydro – for nuclear we know from page 30, line 32 that it was 2620 TWh in 2004). With this taking into account, renewables accounted for much more as the 17 % in line 35, probably more than 25%. (Manfred Treber, Germanwatch)	Noted
4-918	A	35	35	0	0	In the chapter and even more in the summaries, energy supply option should receive fair treatment, in particular when comparing potential for mitigation. The use of "equivalent primary energy" for hydro is therefore correct when compared	Accepted

						with nuclear. But this paragraph may receive more clarity with a graph. One best way should be to give a potential share of electricity supply and heat supply separately (in TWh). (ANTOINE BONDUELLE, Université Lille II)	
4-919	A	35	35	35	35	"including traditional biomass, (9%)" -- how does this correlate to Table 4.3.1 Insert footnote to explain this. U.S. Government (Government of U.S. Department of State)	Accepted
4-920	A	35	36	35	0	Add resource paragraphs like other sections. Add technical potential estimates and references (regionally or worldwide). U.S. Government (Government of U.S. Department of State)	Accepted
4-921	A	35	37	35	40	Growth of renewable energy technologies expressed in terms of historical installation is not as effective as growth in market share. Some of the technologies exhibit high growth figures because they are still in a research phase where an additional plant may double capacity. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Accepted
4-922	A	35	37	35	0	Wind at <0.7% …total renewable energy vs. electric power production? U.S. Government (Government of U.S. Department of State)	Noted
4-923	A	35	38	0	0	delete hot water (Ajay Guha, Asian Development Bank)	Accepted
4-924	A	35	40	35	43	Suggest adding, "…sustained policy intervention. This policy intervention continues to grow in both OECD and non OECD countries (Martinot 2005/2006), yet is still a fraction of approx US200bn annually subsidies for fossil fuels. (Steve Sawyer, Greenpeace International)	Accepted
4-925	A	35	43	35	44	Mention that there are other views (http://www.wbgu.de/wbgu_jg2003_engl.html, figure 1) showing that a much larger share of renewables is feasible. The German advisory council on Global change showed that 50% of renewables on primary energy is feasible until 2050. (Robert Pitz-Paal, German Aerospace Centre (DLR))	Accepted
4-926	A	35	45	0	0	It might be worth making it clearer that this 24% in 1970 was mainly large hydro, as is the 15% in 2001. Also, who are the many that hold the long term renewable vision? Most people, I would have thought, believe that renewables can only be a part of the answer. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Accepted – this is a good reason to emphasize the need of divulge the studies about a larger share of renewables

4-927	A	35	46	0	0	In the sentence, the wording "long term vision held by many" suggest this point is controversial. But consensus does exist (probably even in this chapter) that "a significant contribution can be brought by renewables" especially if no mention is made of other sources. Thus the wording should be "The long term vision held by most experts that renewable…"; alternatively, another version could be "The long term vision held by many that renewable energy can meet an increasing contribution to world primary energy…". (ANTOINE BONDUELLE, Université Lille II)	Accepted
4-928	A	35	46	36	2	The statement could be made much stronger (or supplemented with) such as: "In the long term, renewable energy can potentially supply many times the current world energy consumption while avoiding most or all pollution arising from the use of fossil fuels. The learning investments required to make these technologies economically competitive could be on the order of $100 billion for currently very expensive solar PV technology, and less for other technologies like wind turbines. (Donald Pols, Friends of the Earth Netherlands/Milieudefensie)	Accepted
4-929	A	35	47	36	1	Should read " … to world primary energy supply within a few decades, so as to stabilize or reduce GHG emissions, have led …." (Danny Harvey, University of Toronto)	Accepted
4-930	A	35	0	0	0	Section 4.3.2.5: The cautious tone of the remarks about nuclear fusion should be applied to the discussion about future projections for nuclear fission. Many would recommend that the remarks about nuclear fusion should be even more skeptical. It could be argued, for example, that claims that nuclear fusion might one day become a useful source of energy are so speculative and relate to a time so far into the future that they are not relevant to the current debate. (Kenichi Oshima, Ritsumeikan University)	Noted The difference in cautiousness has been intentionally formulate so that expectations on the early commercialization of fusion energy are lower than that for advanced nuclear fission energy.
4-931	A	36	4	36	4	Good to quote declaration on renewable. Quote as well for nuclear the recent G8 declaration in your nuclear chapter. (DELLERO Nicole, AREVA)	Noted
4-932	A	36	4	36	4	Good to quote declaration on renewable. Quote as well for nuclear the recent G8 declaration in your nuclear chapter. (DELLERO Nicole, AREVA)	Noted
4-933	A	36	7	36	7	….following on the ….". Insert 'up' after 'following' (Government of India)	Accepted
4-934	A	36	10	0	24	The classification is very helpful, although I am not sure is very consistent; for example I would argue that real offshore wind is under technological development,	Accepted

						and Bioethanol ligno-cellulose was a research topic. (Chris Mottershead, BP)	
4-935	A	36	10	36	23	This paragraph confirms that growth figures shown in lines 35 to 40 on page 35 are not relevant since they refer to immature technologies. Growth in market share would be a better indication. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Accepted
4-936	A	36	10	36	24	This part demands a table or a graph (Government of European Community / European Commission)	Accepted – present categories in the table
4-34	B	36	10	36	24	Move solar PV and anaerobic digestion to category 1 (Government of Germany)	Accepted
4-937	A	36	12	36	12	solar water heating (mainly from China more than 60%) (Li Junfeng, Energy Research Institute of National Development and Reform Committee and Secretary General of China Renewable Energy Industry Association.)	Noted
4-938	A	36	13	36	13	change to Bio-ethanol from Sugars (mainly Brazil) and Starch (mainly from USA) (Li Junfeng, Energy Research Institute of National Development and Reform Committee and Secretary General of China Renewable Energy Industry Association.)	Accepted
4-939	A	36	14	36	14	solar PV is used quite widely with more than 80 contries, however it is with very high cost, instead of a small number countries (Li Junfeng, Energy Research Institute of National Development and Reform Committee and Secretary General of China Renewable Energy Industry Association.)	Accepted
4-940	A	36	14	36	17	Probably should also mention tidal power..e.g., plant in Rance Estuary..St.Malo/St.Servan, France, has been operational for many years. Takes advantage of large tidal range to turn turbines using both incoming and outgoing tides. (Jean Bogner, Landfills +, Inc)	Accepted
4-941	A	36	15	36	16	Recommend moving "municipal waste to energy" to line 12 of this page. This is mature and well-demonstrated in many countries. Suggest combining with landfill gas so that line 12 includes "landfill gas and municipal waste-to-energy" (Jean Bogner, Landfills +, Inc)	Accepted
4-942	A	36	16	36	16	change to anaerobic digestion (mainly from China and India) (Li Junfeng, Energy Research Institute of	Accepted

						National Development and Reform Committee and Secretary General of China Renewable Energy Industry Association.)	
4-943	A	36	16	0	0	I believe sales of biodiesel in the EU are at the 60M litre per year level and so it should be in category 1). (David Jackson, McMaster University)	Accepted
4-944	A	36	20	36	20	When this report is published one solar thermal tower 11 Mwe will be delivering electricity to the spanish grid and severeal others be in construction. Please move solar thermal towers in the above category of mature technology with new markets. (Cédric PHILIBERT, International Energy Agency)	Accepted
4-945	A	36	20	36	20	Including bioethanol from ligno-cellulose, bio-refineries in this catgory seems optimistic (Government of France)	Accepted
4-946	A	36	22	36	23	"hydrogen production from algae and water" This is not an energy technology. I would suggest saying "biological hydrogen production involving bacteria and algea" (Wolter Elbersen, WUR, AFSG)	Accepted
4-947	A	36	25	36	30	Says that most mature renewables have been able to compete without policy support, but lists technologies/markets that received considerable policy support. (Joanna Lewis, Pew Center on Global Climate Change)	Noted
4-948	A	36	25	36	32	If subsidies are included as part of price then more countries may exhibit viability of renewable energy technologies and more technologies would also show viability. Exclusion of subsidies tends to show renewables in a poor way. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Rejected
4-949	A	36	25	0	30	25-30. The authors' definition of "competitive" in this context needs to be explained. Later on in the chapter (P98) it is explained that the Japanese government boosted solar PV installation through heavy subsidies (up to 50%) and low-interest loans. Swedish biomass to energy development has been promoted through energy and subsequently carbon taxes on fossil fuels (the carbon taxes are also mentioned on P98). The text on P98 seems to indicate that the Japanese expansion of PV took place during 1997-2002, ie during the duration of the subsidy programme. Certainly, biomass is favoured in Sweden today through exemption from energy and carbon taxes. Also Spanish success of wind power has been dependent on promoting instuments. (Government of Sweden)	Accepted – subsidies, incentives and market mechanisms promote fossils, nuclear and renewables, the problem is mainly redirecting them from the former to the later.

4-950	A	36	27	36	0	Policy support….(include) under today's economic paradigms where environment and other "externalities" nor fossil fuel price risk are accounted for. U.S. Government (Government of U.S. Department of State)	Noted
4-951	A	36	29	36	29	Grid-connected PV, even in Japan is not yet competitive. (Li Junfeng, Energy Research Institute of National Development and Reform Committee and Secretary General of China Renewable Energy Industry Association.)	Competitiveness, profitability and subsidies must be fully analyzed and cleared in detail because grid connected PV systems are the ones with grew mostly last year.
4-952	A	36	29	36	30	Grid-connected PV is not profitable in Japan today. But PV systems are profitable in many parts of the world when sufficiently remote from main electricity grids. (Cédric PHILIBERT, International Energy Agency)	Competitiveness, profitability and subsidies must be fully analyzed and cleared in detail because grid connected PV systems are the ones with grew mostly last year.
4-953	A	36	29	36	29	The description of "… grid connected solar PV in Japan … are all competitive today" can be understood. Japanese government provides a subsidy for solar PVs (see Chater 4, p.98). (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Competitiveness, profitability and subsidies must be fully analyzed and cleared in detail because grid connected PV systems are the ones with grew mostly last year.
4-954	A	36	33	0	38	"Typical construction costs" for new renewables are very different and depend largely on the technology. To give a range on construction costs does not say anything about the renewable energy sources. The construction costs per kW should be specified per technology. (Sven Teske, Greenpeace International)	Accepted – will be clarified
4-955	A	36	33	36	34	These technologies have very low production costs (O&M and fuel) and thus range from $1,000 to 2,500 kW. U.S. Government (Government of U.S. Department of State)	Noted
4-956	A	36	34	36	34	What is the degree of consensus on this cost estimate ? It looks quite optimistic. (Government of France)	Accepted – life has demonstrated that those cost are reducing continuously
4-957	A	36	35	0	0	Nuclear stations have a low dependence on site and I would delete the sentence "On other sites the costs are very variable" (David Jackson, McMaster University)	Rejected
4-35	B	36	38	37	5	Fig 4.3.4 does not support the statement made in the sentence before. No comparison to conventional systems is made. Instead, fig. 4.3.4 shows the dynamics of cost reduction. (Government of Germany)	Noted

4-958	A	37	0	37	0	Fig; 4.3.4: Installed power expressed in MW is not comparable with the produced energy expressed in MWh, used for the other types of energy (Government of France)	
4-959	A	37	0	37	0	Fig.4.3.4 is not clear (Government of France)	Rejected
4-960	A	37	1	0	0	Should not the top axis label be (1000 m3/yr)? (Danny Harvey, University of Toronto)	Noted – will be checked
4-961	A	37	1	37	3	Table 4.3.4 may be more useful if conventional fuels were included. That would show growth in market share. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Noted
4-962	A	37	1	0	0	Figue 434: The figure suggests that learning is not a continuous process. The learning rates mentioned are pretty high, other studies suggest very different elarning rates. I would expand the learning discussion in this chapter, it is a key policy issue that is not treated properly. (Dolf Gielen, International Energy Agency)	Noted – no ref. provided
4-963	A	37	1	37	1	Where is offshore wind? In general, but also in Figure 4.3.4., work from Martin Junginger on learning curves for offshore wind and for instance can be included (Government of European Community / European Commission)	Noted
4-964	A	37	1	37	0	Figure - "Price" on x axis on right side – Is this price based on the U.S., Brazil or a combination of both? Does this include taxes, distribution charges, tax credits? Insert footnote to explain this. Also, curve for ethanol – not sure if this is for sugar and starch-based ethanol or what. Current experience is with sugar and starch-based ethanol, which are both mature technologies that are unlikely to decrease in costs as much as this or as much as new cellulosic technology would decrease. Is this data accurate? U.S. Government (Government of U.S. Department of State)	Accepted regarding the footnote
4-965	A	37	5	37	9	Aadd Japan in the country list here. <Rationale> Since Japan has set its renewale energy target, such as "Kyoto Protocol Target Achievement Plan" and please. (Shigeo Murayama, The Federation of Electric Power Companies)	Accepted
4-966	A	37	15	37	0	Insert the following: In 2006, U.S. President Bush launched the Advanced Energy Initiative that outlines an aggressive plan to help the United States to move beyond its dependence on	Rejected – text proposed cover far broader issues and it is weakly related to renewables

						fossil fuels through expanded development of alternative energy sources. The Advanced Energy Initiative provides for a 22% increase in funding for clean-energy technology research at the U.S. Department of Energy in two vital areas. 1) Changing the fuels for vehicles – energy security can be improved through greater use of technologies that reduce oil use by improving efficiency, expansion of alternative fuels from homegrown biomass, and development of fuel cells that use hydrogen from domestic feedstocks. 2) Changing the way homes and businesses are powered. The high costs of natural gas and electricity can be addressed by generating more electricity from clean coal, advanced nuclear power, and renewable resources, such as solar and wind. U.S. Government (Government of U.S. Department of State)	
4-967	A	37	16	0	0	The sentence states that "many renewables" are intermittent – this is not correct. Only solar PV and onshore wind energy are intermittent while hydro, biomass and geothermal and, to some extent solar thermal power plants, are dispatchable energy sources. (Sven Teske, Greenpeace International)	Accepted, also OTEC is dispatchable
4-968	A	37	16	0	0	Intermittent is the wrong word. Should be replaced by variable. (Gerard van Bussel, Section Wind Energy, Faculty LR, TU Delft.)	Rejected – variable and intermittent are different concepts and both of them are applicable to wind
4-969	A	37	16	37	19	Delete. See justification in overall comments on variability/intermttency. (Christian Kjaer, European Wind Energy Association)	Accepted
4-970	A	37	16	37	16	It would be worth mentionning the very limited energy storage capacities presently available (Government of France)	Accepted
4-971	A	37	17	37	17	Energy storage will (not "may") be needed, if intermittent renewable energy sources are to make more than a niche/negligible contribution. (Christopher Green, McGill University)	Accepted
4-972	A	37	17	37	17	Energy storage will (not "may") be needed, if intermittent renewable energy sources are to make more than a niche/negligible contribution. U.S. Government (Government of U.S. Department of State)	Accepted
4-973	A	37	19	0	0	OK, but only if a large penetration grade is realised (typically > 25%). Below that no additional strorage capacity is demanded (Gerard van Bussel, Section Wind Energy, Faculty LR, TU Delft.)	Accepted
4-974	A	37	21	37	22	"Since the TAR large industry corporate companies…..have invested in	Accepted

						…..sources". But this is a small fraction of the investment related to conventional fossil fuels and fossil-fuel-based technologies. (Government of India)	
4-975	A	38	0	39	0	The IPCC report does not adequately refer to the possibility of extensive CO2 emissions from hydroelectric facilities. To maintain an adequate supply of energy resources in reserve, most dams impound water in extensive reservoirs. However, these reservoirs often emit large amounts of carbon dioxide from rotting vegetation and carbon inflows. The comprehensive World Commission on Dams report noted that "a first estimate suggests that gross emissions from reservoirs may account for between 10% and 28% of the global warming potential of greenhouse gas emissions." (This study does not appear to be cited in the IPCC report, even though it is regarded as the most authoritative report on hydroelectric dams). This observation requires further study and consensus-building, but the contention of some environmental scientists is that reservoirs associated with hydroelectric facilities may have an increase of greenhouse gas emissions that are roughly comparable to a similar-sized gas-fired power plants. U.S. Government (Government of U.S. Department of State)	Noted – the WCO report could be cited as a reference, but the main emissions from dams are CH4 instead of CO2. The final comment would apply only to new HE plants.
4-976	A	38	2	38	9	There are now statistics on investment flows into renewable energy. Trade publication, New Energy Finance (www.newenergyfinance.com), published "Cleaning Up: Focus on Private Equity & Venture Capital Investment in Clean Energy Technologies, Companies & Projects", 13 June 2006. This summarises the types of investment currently going into the sector, concluding that in 2005 "total global investment in clean energy (equity and debt)" was $48.9 billion [pers comm with the editor, indicates this is up from around an estimated $35 billion in 2004]. With a slightly different set of criteria and technologies, the 'Renewables Global Status Report, 2006 Update" (Eric Martinot, for REN21, www.ren21.org) calculates total investment at $38 billion in 2005 (up from $30 billion). (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	Noted
4-977	A	38	4	38	9	Donor programmes often increase barriers by exhibiting artifical non-sustainable markets while project lasts. It is difficult to assess the impact of these programs in terms of long term market development. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Accepted
4-978	A	38	17	39	16	Suggested revised text for section 4.3.3.1 Hydroelectricity Large (>10 MW) hydroelectricity systems account for about 2700 TWh of final	Noted – section will be reviewed in order to cut its extension, assuming that the main ideas

						energy, providing 17% of global electricity and 90% of renewable electricity (2006 World Atlas & Industry Guide, U.S. Energy Information Administration 2004). If this electricity would have been produced by coal, 25 EJ/yr of primary energy would be required; in this scenario, hydroelectric systems avoid releasing 2700 Mt CO2/yr into the atmosphere. Hydro projects under construction could increase their share of electricity by about 4.5% on completion (WEC, 2004d)." Small (<10 MW) and micro (<1 MW) hydro-power systems, usually run-of-river systems, have provided electricity to many rural communities in developing countries such as Nepal, but in total they generate slightly less than the equivalent of 1 EJ/yr of primary energy (WEC, 2004d). The global technical potential of small and micro hydro is around 150-200 GW with many unexploited resource sites available at generating costs between USD0.02-0.06/kWh but with additional costs needed for power connection and distribution. These costs can be prohibitive in remote areas, even for mini-grids, and some form of financial assistance from aid programmes or governments will be necessary. Hydro power is one of the industrial-scale renewable technologies that can be deployed in a routine, straightforward fashion. It is estimated that building more large hydropower systems could provide an additional equivalent of 60 EJ/yr, mainly in developing countries. Compared to fossil fuelled generation, hydroelectric systems raise exceptional issues, because they can provide services such as flood control, urban water supply, recreation and irrigation. The benefits of these services need to be taken into account for any given development. These multi purpose issues are significant: about 25% of storage capacity of world reservoirs directly serve irrigation schemes that feed 12 to 15% of world population (F.Lempérière, ICOLD, Hydropower and Dams, 2006). About 2500 large dams are devoted only to flood mitigation. Even if about 80% of reservoir storage serve hydropower generation, a significant hydropower potential remains at reservoirs that do not currently provide electricity generation. Another characteristic of hydroelectric systems is the quick response, capable of meeting demand fluctuations and peak electricity demand (IEA Hydropower Agreement, Hydropower and the Environment: Present Context and Guidelines for Future Action, 2000). Because of this service, hydro plants are often designed with	are properly reflected and references adequately cited.

						excess capacity, to ensure that enough capacity is available during peak demand. As a consequence, the capacity factors of hydro plants should not be compared with those of thermal power plants. For thermal power plants, a high capacity factor is often an indicator of good performance. For hydropower, a low capacity factor can indicate a very high performance, notably during periods of peak demand. This quick response of hydro plants can also support the development of intermittent renewables, such as wind power, who require a backup capacity when the wind is not blowing. In this context, hydro and wind systems should not be considered as competing technologies, as more hydropower will allow a greater penetration of wind power. This is the case in hydro dominated regions such as in Quebec (Canada) where about 3500 MW of wind power is being developed. In Denmark, the large wind power capacity is mainly supported by hydro plants in other Scandinavian countries. Research initiatives have therefore been launched in the past few years, to assess the potential of hybrid hydro/wind systems (IEA, 2006b). In the future, building more hydro plants can reduce greenhouse gas emissions and provide other benefits. Such a development is however dependant on good management of projects, in various areas: - Management of social issues. This issue is relevant to many large projects, where local populations may be displaced. Benefit sharing is becoming a more frequent practice, but may need to be widely used. - Hydro plants can also cause disruptions to river ecosystems and fisheries. This is a major environmental issue that may need mitigation or compensation measures. Programs to support reservoir fisheries can also offset some of the impacts on river fisheries. - Life cycle assessments of hydroelectric systems have shown that, for the vast majority of projects, the greenhouse gases (GHG) emissions from hydro systems are very low, at a similar level as wind power life cycle emissions (WEC, 2004). However, research has shown that measured "gross" GHG emissions over some tropical reservoirs can be significant, due mainly to anoxic conditions that favour methane production (A. Dos Santos). Research has also confirmed high level of GHG emissions from natural aquatic environments (Cole and Caraco, 2001; Richey et al., 2002). This means that the assessment of reservoirs should consider pre-impoundment natural emissions. Producing estimates of these "net" emissions is a research priority.	

						Because of social and environmental concerns, obtaining permits for hydroelectric development is often a constraint. In response to these concerns and to improve its environmental and social performance, the industry has been working for many years on sustainability guidelines. A multi country Initiative on Hydropower was set up by the International Energy Agency, with a final report in 2000 (IEA Hydropower Agreement, 2000). This process was followed by the adoption of Sustainability Guidelines by the International Hydropower Association in 2004 (IHA Internet site). To ensure a rigorous approach, the impacts of hydroelectric systems should always be compared with the impacts of other competing options. When hydro development avoids the use of fossil fuels, the benefits in reducing air pollution (greenhouse gases, nitrogen oxides, sulphur dioxide, toxic metals) should be included in the environmental assessment. (Luc Gagnon, Hydro-Quebec)	
4-979	A	38	20	0	0	IEA statistics suggest it is much lower than 25 EJ, in 2005 OECD gross generation was 1345 TWh and non-OECD 1546. This is around 10.4 EJ. (Michael Taylor, International Energy Agency)	Noted – will be checked
4-980	A	38	20	39	8	The chapter on hydropower starts by saying that hydro avoids releasing 2.202 GtCO2/yr of carbon into the atmosphere if generated from a similar amount of coal-fired power. This statement does not seem to be in line with what is said about GHG from hydropower on page 39 line 2 - 8. Here it is stated that hydropower reservoirs emit GHG and in some cases as much as a CCGT plant. These statements build upon measuring gross emissions from tropical reservoirs and have lately been taken, more or less, to be a general trait of all hydropower. The CDM Executive Board has even stated that all hydropower reservoirs with low power density (W(installed capacity)/reservoir area) have the same emissions whether they are situated in the tropics or in the arctic region. However, the question of GHG from hydropower has been treated in another Second Order Draft from the IPCC, namely the Draft on Guidelines for National Greenhouse Gas Inventories. This draft was finalized on Mauritius in April 2006. There both the method for measuring GHG from reservoirs and especially the gross emission approach were turned down. The recommended method is now to estimate changes in carbon stock. As far as we understand, this means that the net CO2 contribution from the power scheme is to be estimated. Also the methane emissions were placed	Noted – the statements in pages 38-39 could be excluded or alternatively also cited the new finds on April 2006, as quoted here.

						in an appendix, signalling that the scientific understanding of methane emissions from reservoirs is not good enough. The issue of GHG from hydro is, according to the decisions taken by the IPCC in April, not decided and the statements in the Mitigation Draft is not in accordance with what the IPCC itself is now saying in the Guidelines for National Inventories. Statkraft as a company will certainly not have problems with GHG emissions from hydro. However we are of the opinion that the question of GHG from hydro should be solved and the picture given should be correct. For the time being this issue is charged with too much uncertainty. A major climate opportunity may be lost if hydropower is made responsible for emissions that are not real. Until the GHG question is solved one should regard hydropower as a clean source until the opposite is a proven fact. The statements on page 38 and 39 regarding GHG should therefore be excluded. (Tormod André Schei, Statkraft AS)	
4-981	A	38	20	38	22	25 EJ is primary energy, if the electricity would come from fossil fuels, at about 35% efficiency. This needs to be explained, otherwise the calculation appear in error, if these 25 EJ are considered as final energy. (Replacement text is proposed further in the list of comments) (Luc Gagnon, Hydro-Quebec)	Accepted
4-982	A	38	20	38	20	It is not recommended that large-scale hydropower be defined as over 10 megawatts. Rationale: It seems there is room to include a mid-level hydropower range. Recheck numbers at 10MW is not large, or reference specific BP definition. U.S. Government (Government of U.S. Department of State)	Rejected – the definition in comment A-4-978
4-983	A	38	21	0	0	Please give also the number of TWh produced with large hydro '... TWh which is 17% of global electricity ...' (Manfred Treber, Germanwatch)	Accepted
4-984	A	38	26	38	31	The implication given is that capacity factors of dams can be improved by technological developments. This is true only to a limited extend, variation in water levels from rainfall is the main factor. (David Jackson, McMaster University)	Accepted
4-985	A	38	26	38	29	When discussing the criteria capacity factor, the text applies a thermal power plant logic to hydropower. For most thermal plants, a high capacity factor is an indicator of high reliability in meeting base load demand. In contrast, hydropower plants are often designed with excess capacity to meet seasonal and daily fluctuations in demand. This is general practice because hydro plants have very short ramp time,	Noted

						allowing them to meet fluctuations in demand. For many hydro plants, this translates in a low capacity factor, which is often an indication of a very high level of service from the plant, ensuring reliable electricity supply, even in the most difficult conditions. (Replacement text is proposed further in the list of comments) (Luc Gagnon, Hydro-Quebec)	
4-986	A	38	27	38	27	Please add "rated capacity" to "capacity factor" at the end of the sentence. There is probably a large potential for repowering existing hydroelectric plants with more powerful turbines, and this seems different than improving the "capacity factor". It would be interesting to put some figures on this repowering potential, but I do not know them. (Cédric PHILIBERT, International Energy Agency)	Noted – it would be worthy to take it into account
4-987	A	38	29	38	31	Add a sentence that reads "In Japan, pumped storage generation has been already been in practical use and 41sites with the total capacity of 24,659.04MW have been in service."(FY 2004, Data from the Federation of Electric Power Companies, Japan) <Rationale> In Japan, many large-scale pumped storage power generation sites have already graduated from study-phase and have been in practical services. (Shigeo Murayama, The Federation of Electric Power Companies)	Accepted
4-988	A	38	29	38	31	It is misleading to say that Expansion of hydropower capacity requires continuous technology improvements to maximize the use of existing plants. As indicated, research is being conducted related to systems such as hybrid hydro/wind and hydro/hydrogen. But the purpose of this research is to use the high level of flexibility of hydropower, to improve development conditions for wind power and hydrogen production. It is not the "expansion of hydropower" that requires technology improvements, as written. (Replacement text is proposed further in the list of comments) (Luc Gagnon, Hydro-Quebec)	Accepted
4-989	A	38	33	38	34	To say "Hydro power is one …….in a routine and straighforward fashion" This is an exaggeration. Suggest that the last part of the sentence be omitted i.e.drop "that can ….routine." (David Jackson, McMaster University)	Accepted
4-990	A	38	34	0	0	This figure from BP of 65 EJ additional generation maybe a bit high. The IEAs Hydropower Immplementing Agreement estimates the worlds technically feasible hydro generation potantial at 14 000 TWh (50EJ), and that only 8000 TWh (29 EJ)	Accepted

						of that is considered economically feasible currently (see IEA 2006, Energy Technology perspectives). (Michael Taylor, International Energy Agency)	
4-991	A	38	36	38	37	The data indicating that 25% of reservoirs having hydro generation is doubtful. The confusion comes from the fact that many very small dams have no hydropower generation. A recent article (F.Lempérière, ICOLD, Hydropower and Dams, 2006) present an assessment based on overall storage capacity of reservoirs. This assessment thereby consider the relative size of projects and concludes that about 80% of storage capacity serve some hydro generation. (Luc Gagnon, Hydro-Quebec)	Accepted
4-992	A	38	40	38	43	On the environmental concerns related to large hydro power, three references are quoted. The one : Rowe, 2005, seems to an article of the magazine "New Scientist" which, looking at the title, seems to be polemical rather than providing guidelines shared by a specific community. I recommend that this reference is not included, if my guess is true. (Jean-Yves CANEILL, EDF)	Accepted
4-993	A	38	40	38	43	It is accurate to mention that many environmental groups do oppose large hydropower and support other renewable sources. However, the reason for this opposition is important: the priority of many groups is wind power development, and they fear that, because of its low cost, hydro development will prevent wind power development. But as the second order draft clearly demonstrate, both developments will be needed. It is also accurate to mention that guidelines have been developed, but the quoted references are out of date. The most important are the IHA Sustainability guidelines. They are based on an IEA process that lasted many years. (Replacement text proposed further down). (Luc Gagnon, Hydro-Quebec)	Accepted
4-994	A	38	45	39	1	While protest groups object to various energy options (e.g. wind and nuclear are mentioned), they are not portrayed as a determining factor. In the case of hydropower one is left with the impression that these protest groups might rule out further expansion. This gives a misleading impression as hydro projects are proceeding in many countries, for example China, Brazil and Iceland. (Robert Chase, International Aluminium Institute)	Accepted
4-995	A	38	45	38	45	The text makes a general statement concerning major social disruptions. This is clearly excessive, since the wording would apply to all projects. Social issues are effectively important for many projects, but should not be labelled "disruptions". In	Accepted

						China, which puts in service about 4000 MW of hydro each year, social issues are unavoidable considering population density. Per unit of energy, these social issues are not worse than those related to other options, such as coal fired generation. About a quarter of all deaths in China are related to poor air quality, mainly caused by coal combustion. (Luc Gagnon, Hydro-Quebec)	
4-996	A	38	46	38	47	As currently worded, the issue of gross carbon dioxide and methane emissions could be misleading and it surely requires a more detailed explanation. The distinctions between gross and net emissions should be discussed. There are other references to include, other than A. Dos Santos (not DosSantosa). The differences between tropical reservoirs and those in other climates should also be discussed. The comment that explains the source of GHG emissions (due to gradual decay of flooded vegetation) is incomplete and does not consider the conclusions of recent scientific research. Decay is effectively one source, but it is a minor one, relative to the carbon flushed into reservoir from surrounding ecosystems. Moreover, in the few cases where high gross GHG emissions have been measured, the major contribution is due to methane from anoxic conditions (when considering the higher GWP of methane). So it would be better to mention that anoxic conditions are the key source (if there is not enough space to explain all the related issues). (Luc Gagnon, Hydro-Quebec)	Accepted
4-997	A	38	48	39	1	Delete offensive language."…strong opposition from human rights and 'green' groups based in wealthy countries."Since this sentence does not add any necessary information, but misrepresents the overall issue significantly it should be deleted. Even if one of the authors has had a negative personal experience or personal frustrations, this should not find its way into a scientific publication. (Sven Teske, Greenpeace International)	Accepted
4-998	A	38	48	39	1	The cheap shot at '"green" groups based in wealthy countries', is prejudiced and counterfactual, as would be clear if the authors knew anything about the real nature of the opposition to large dam projects in, for instance China, India and Brazil. It has no place in this report. (Steve Sawyer, Greenpeace International)	Accepted
4-999	A	38	48	38	48	The issue of related evaporative water losses could be removed or taken in a broader perspective. Evaporation can be an issue for some reservoirs in arid climate. But in such climate, reservoirs provide drinking water and irrigation, which are important services that may not be available otherwise.	Accepted

						(Luc Gagnon, Hydro-Quebec)	
4-1000	A	39	1	39	2	"Whether large hydro-power projects bring electricity to the poorest is also questionable" is a comment which could apply to coal, gas or any power source for national grids. In Brazil and Canada the whole population depends on a largely hydro powered national grid. Whether or not the national grid extends to the poorest communities has nothing to do with hydro as an energy source. (Robert Chase, International Aluminium Institute)	Accepted
4-1001	A	39	1	39	2	Whether hydro-power systems bring electricity to the poorest is a complex issue that has produced conflicting research results. Quoting one opinion from one environmental group (WWF) opposed to hydropower is not consistent with IPCC practice. This statement could be removed, or the issue discussed more completely, notably by including World Bank assessments. Since reservoirs are often designed for irrigation, drinking water and hydro, all components of projects need to be included in assessing the benefits to the poor. (Luc Gagnon, Hydro-Quebec)	Accepted
4-1002	A	39	1	39	3	What does "Heat" mean as a fuel source for primary energy? Heat is usually considered to be an energy product, not a source. U.S. Government (Government of U.S. Department of State)	Accepted – heat is an energy service (this comment is misplaced)
4-36	B	39	2	39	9	Add: The GHG emissions of large hydropower plants strongly depend on the regional area (relevant mainly for tropical areas), the ratio of installed capacity to the flooded area, the volume flow through the turbine and the type of power plant (reservoir, run-of-river). (Government of Germany)	Accepted
4-1003	A	39	9	39	10	Additional text on large hydropower - "In addition to avoiding significant amounts of GHG emissions today (>2 GtCO2/yr relative to coal fired sources per page 38, line 20), large hydropower provides a reliable source of local energy. Locally available hydropower provides a secure source of supply (energy security) while minimizing potential safety, ecological, and economic risks (such as potential spills from the transportation of liquid petroleum prodcts, hazards associated with the trasnport and storage of CNG) inherent with importing and transporting large quantities of energy into local communites. (Kenneth Martchek, Alcoa)	Accepted – don't need to be added but included in the section review.

4-1196	A	50	32	51	37	Section 4.3.3.4 focuses almost exclusively on geothermal energy to generate electricity. There should be some discussion of its use and potential for space and water heating, which should be easier because of the lower required temperatures. (Danny Harvey, University of Toronto)	Accepted
4-1197	A	50	32	51	37	Under geothermal, the projected capacities globally may be shown like the way global solar potential is shown. This gives the potential of geothermal globally. (Government of India)	Noted
4-1198	A	50	32	51	0	In the section 4.3.3.4 Geothermal discussion, in summary tables and in summary sections, the Geothermal Energy category should be sub-divided into two categories: Near-surface Geothermal and Deep Geothermal. These two energy categories have dramatically different costs, different potential resource bases, and different levels of technological maturity. Near-surface geothermal energy systems account for virtually 100% of all the current geothermal energy production (largely in Iceland), have reasonably attractive unit costs and a limited potential resource base of about several EJ. Deep Geothermal Energy Systems are technologically immature, have higher unit costs, are not in current use, and represent most of the stated Geothermal Resource base (stated in Table 4.3.1) of 5,000 EJ. Combining these two disparate resources and technologies into one category tends to distort the representation and discussion of both. (If the phrase "Enhanced geothermal" is meant to refer to Deep Geothermal, than the phrase should be explicitly defined so that the readerunderstand that definition.) The point is that the discussion and representation of Geothermal should clearly distinguish between these two approaches (just as solar is divided into Solar-thermal-electric, PV, and solar heating and cooling). Table entries, such as those in Table 4.3.2, should clearly exhibit the unit cost of energy, current usage and potential resource base of both categories of geothermal systems. U.S. Government (Government of U.S. Department of State)	Accepted
4-1199	A	50	37	50	41	Enthalpy is the technically correct term, but even those of us who took thermodynamics several decades ago have to think about what it means. If communications is the goal, replace enthalpy with heat content. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Noted
4-1200	A	50	37	50	41	Enthalpy is the technically correct term, but even those who took thermodynamics several decades ago have to think about what it means. If communication is the	Noted

						goal, replace enthalpy with heat content. U.S. Government (Government of U.S. Department of State)	
4-1201	A	51	0	52	0	For geothermal, The only mention of long-term potential is a brief mention of 88 GW "long term potential" in the US. I suggest including the figure of 5000 EJ a year that is presented in chapter 5 of the 2001 World Energy assessment, and a more thorough discussion generally of this high-potential technology. (Donald Pols, Friends of the Earth Netherlands/Milieudefensie)	Noted
4-1202	A	51	5	51	5	What does the phrase "geothermal resource consents being declined" mean? (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted – will be clarified
4-1203	A	51	5	51	5	What does the phrase "geothermal resource consents being declined" mean? Change text to internationally recognized term "permits"? U.S. Government (Government of U.S. Department of State)	Accepted – will be clarified
4-1204	A	51	8	51	10	Something is wrong with the figure 1,000 TWh/yr. It should be around 64 TWh/yr ?? (JUAN CARLOS ABANADES, INCAR-CSIC)	Noted – will be checked
4-1205	A	51	14	51	15	It is important to include potential in other regions eg East Africa. AFREPREN (www.afrepren.org) (Norbert Nziramasanga, Southern centre for Energy and Environment)	Noted
4-1206	A	51	21	51	28	A new paragraph should be added, in order to introduce the geothermal production from shallow sources (soils, rocks, groudwater) with heat pumps in order to cover needs for heat at low temperature (building heating and cooling, production of sanitary hot water). Such types of geothermal systems develop rapidly in Europe, and the potential for growth is huge. f.i., the yearly increase in France could be equal to the presently installed capacity on conventional district heating systems exploiting deep aquifers (i.e. 150.000 housing/year, i.e. half the constructions of new houses). (VARET jacques, French Geological Survey)	Accepted
4-1207	A	51	30	51	30	Enthalpy is the technically correct term, but even those of us who took thermodynamics several decades ago have to think about what it means. If communications is the goal, replace enthalpy with heat content. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Noted (repeats comments 4-1199 and 4-1200)
4-45	B	51	30	51	30	Enthalpy is the technically correct term, but even those who took thermodynamics several decades ago have to think about what it means. If communication is the goal, replace enthalpy with heat content. U.S. Government	Noted (repeats comments 4-1199, 4-1200 and 4-1207)

						(Government of U.S. Department of State)	
4-1208	A	51	41	51	43	Should be “Concentrating solar power …”. Change “the way” to “whether” and change “and” on line 43 to “or” (Danny Harvey, University of Toronto)	Accepted
4-46	B	51	43	51	0	“…(500-1000 suns)”…check. This seems low Provide reference or example. U.S. Government (Government of U.S. Department of State)	Accepted – will be checked
4-1209	A	51	46	52	2	"Storage of surplus solar heat" could certainly solve the intermittency problem. But how can we store large quantities of solar energy in practice? and at what energy and monetary cost? (JUAN CARLOS ABANADES, INCAR-CSIC)	Rejected – needs confirmation and evaluation in practise
4-1210	A	51	47	51	47	Studies in Australia have considered coal & solar thermal (Liddell power plant) - this should be mentioned, particularly as coal brings particular low-cost generation to balance the high cost of solar Ref: p15 Greenpeace "Solar Thermal Power 2020, Exploiting the Heat from the Sun to combat climate change" (Christine Copley, World Coal Institute)	Noted
4-1211	A	52	0	52	0	Figure 4.3.12 Remember to add the "legend" (José Somoza, National Institute of Economic Research)	Noted - will be added
4-47	B	52	2	52	0	“Combined fuel systems? Commercial trough are already >95%; Kramer junction” U.S. Government (Government of U.S. Department of State)	Rejected – comment misplaced
4-1212	A	52	15	0	0	Add that : energy transport through high voltage DC transport from region with high insolation (e.g. Northern Africa) to central Europe is technical feasible and an economically attractive option to balance the energy mix (www.dlr.de/tt/trans-csp) (Robert Pitz-Paal, German Aerospace Centre (DLR))	Accepted
4-1213	A	52	15	52	19	Check number and units. "kWh m2" seems wrong unit for "direct insolation" that should be given as kW/m2. How many km2 is that 1% of world´s desert area??. Is a 10% conversion efficieny from solar to electricity achievable today? What is today´s standard efficiency? (JUAN CARLOS ABANADES, INCAR-CSIC)	Accepted – will be checked
4-1214	A	52	15	52	15	2000-2500kWh m2, add "per year" (Government of France)	Accepted – will be added
4-1215	A	52	16	52	16	125 GWh, add "per year" (Government of France)	Accepted – will be added

4-1216	A	52	24	52	0	It seems odd that California be used as an example to discuss solar unit capacity since in the proceeding Figure (4.3.12) California does not even fall into a region of high direct insolation. Clarification is suggested. (Government of Japan)	Noted – will be clarified
4-1217	A	53	1	53	4	The Reference (Sargent and Lundy, 2003) is missing in the list! Add: "New studies have shown far lower costs of 8-12 ct/kWh and 4-8 ct/kWh in the long run." Compare Table 4.2.2, for instance! References: a) F. Trieb et al.: Concentrating Solar Power for the Mediterranean Region, (MED-CSP). Study prepared for the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), March 2005. http://www.dlr.de/tt/MED-CSPF. b) Trieb et al.: Trans-Mediterranean Interconnection for Concentration Solar Power (TRANS-CSP), Study prepared for the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), April 2006. http://www.dlr.de/tt/trans-csp (,)	Accepted – will be added
4-1218	A	53	1	53	4	Mentions potential future cost of trough and tower plants, but doesn't say what current cost is. (Joanna Lewis, Pew Center on Global Climate Change)	Noted
4-1219	A	53	3	0	0	Add that concentrating solar power offers the benefit to combine electricity generation and sea water desalination in regions where radiation is high and water resources are scarce (www.dlr.de/tt/med-csp, Chapter 5.4) (Robert Pitz-Paal, German Aerospace Centre (DLR))	Noted
4-1220	A	53	4	53	5	Please update with reference to two recent studies from the German Aerospace Center (DLR): MED-CSP shows that concentrating solar power should be cost-effective in the Middle-East North African region with one to two decades and provide up to 50% of the electricity at that time to that region. TRANS-CSP shows that modern high voltage direct current lines could deliver competitive solar electricity from North Africa to Europe, covering up to 15% of its electricity in 2050. See http://www.dlr.de/tt/med-csp and www.dlr.de/tt/trans-csp (Cédric PHILIBERT, International Energy Agency)	Noted
4-1221	A	53	9	0	0	After "glazed collectors," add "for daylighting," (Danny Harvey, University of Toronto)	Accepted – will be added
4-1222	A	54	1	54	1	Statement implies that subsidies affect cost. I think the discussion refers to retail price as opposed to cost. Cost is driven by technical and economic parameters and subsidies tend to shiled end users from some of the cost. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Noted

4-1223	A	54	2	54	2	Please delete "and government support" here, as the costs indicated do not include government support. The difference is explained by the difference in resource and moreover climate conditions - double circuit is needed in Germany but usually not in Greece, for example, to prevent freeze. (Cédric PHILIBERT, International Energy Agency)	Accepted – will be deleted
4-1224	A	54	9	54	11	The mention of solar cooling is useful for policy, but the emphasis on cost in the reference is misleading for a technology not yet in wide diffusion. The sentence should read "A number of pre-commercial cooling technologies exist with nearly one hundred systems in Europe representing 19000 m² and a total cooling power of 7 MW". The end of the sentence could read "the costs of active cooling systems are still higher than conventional systems and with efficiency measures in insulation and systems". (ANTOINE BONDUELLE, Université Lille II)	Accepted – will be arranged
4-1225	A	54	9	54	11	Please update and replace 19,000 with 24,000 and 4,8 with 9 MW. Please replace Philibert 2005 with Philibert 2006: Philibert, Cédric, 2006, Barriers to the diffusion of solar thermal technologies, OECD and IEA Information Paper, Paris (forthcoming) (Cédric PHILIBERT, International Energy Agency)	Accepted – will be replaced
4-1226	A	54	12	54	12	Two other areas for using solar heat must be mentioned here: use of solar heat for agriculture and industry needs, and use of solar heat for cooking. Heat represents about a third of the “useful” energy in the agriculture and industry sectors. While some processes require very high temperatures, such as melting metals, others require medium temperature heat, especially in food, chemical and textile industries – often important economic sectors in developing countries. Moreover, one of the most promising applications for active solar heating worldwide is the drying of agricultural products. Desalination is another important area of application, as water scarcity often hits areas with high solar insulation. There is a wide variety of stationary collectors (not tracking the sun) with selective coating and excellent insulation can reach 100 C or more with good efficiency. Higher temperature solar heat requires concentrating solar rays and sun tracking. Whilst state-of-the-art parabolic trough collectors for solar thermal power plants can reach 400 C with high efficiencies, the majority of industrial process heat is consumed at temperature below 250 C and above 600 C. Therefore, smaller collectors, that could possibly installed on roofs, and optimised for temperatures up to 250 C are under development. Solar cookers allow preparing meals from mid-day to evening. Some	Accepted – will be arranged

						are simple boxes with one glazed top; others use aluminium sheets to concentrate the solar rays and reach higher temperatures. The main purposes are to avoid deforestation, save time currently spent in gathering biomass, and alleviate health effects of burning biomass (or coal) in inefficient devices, especially developing countries. Cost-effective as they are they could also contribute to eradicate energy poverty in providing rural and urban poor with an effective substitution to their greater energy expenses – cooking fuels. (Cédric PHILIBERT, International Energy Agency)	
4-1227	A	54	12	0	0	About PVC shorter than one page, it is too short to a very important technology. I expect low cost thin-film PVC would be commercialized (large lot production has become possible) within a few (shorter than 5) years. (Yutaka Tonooka, Saitama University)	Noted
4-1228	A	54	15	0	0	The section on PV does not have anything on PV-Thermal - installations where the excess heat from PV panels is converted into useful thermal energy. See e.g.: Bakker, M., Zondag, H.A., Elswijk, M.J., Strootman, K.J. and Jong, M.J.M. (2005), Performance and costs of a roof-sized PV/thermal array combined with a ground coupled heat pump, Solar Energy Vol. 78, pp. 331-339. (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted
4-1229	A	54	15	54	16	The consideration on total supply from the sun is important but misplaced, for it is relevant for all solar technologies not only PV. Please move it to p.35 under renewable energy. (Cédric PHILIBERT, International Energy Agency)	Accepted – will be done
4-48	B	54	16	54	17	Units appear to be wrong. Usually, when refer to "insolation" this means power density, with units of kw/m2. This sentence is written with kWh/m2, which usually refers to energy. If using kwh/m2, meaning energy, the range should be 4 kwh/m2 for temperate areas to 7 kWh/m2 for dry desert areas. If using kW/m2, meaning power density, the range should be 1 kW/m2 for a temperate region to 1.2 kW/m2 for the dry desert areas. There is NO way this could be what is in the sentence. U.S. Government (Government of U.S. Department of State)	Accepted – will be corrected
4-1230	A	54	19	54	19	solar "technical potential" of 1600 EJ/yr. The "technical potential" of solar is more than two orders of magnitude smaller than 1600 EJ/yr, if technologies for large scale storage cannot be developed. Even with storage, land and other resource requirements are likely to limit solar energy's contrK13K14ibution to 10-15% of the so-called "technical potential" (See Green, Baksi, and Dilmaghani, "Challenges	Noted

						to a Climate Stabilizing energy Future" , Energy Policy, In Press (likely publication date December, 2006) (Christopher Green, McGill University)	
4-1231	A	54	19	55	0	For solar PV, the stated technical potential is 1600 EJ. It would do well to mention that it is more than three times current world energy consumption. Also, it would be appropriate to have a discussion on how this potential could be realised, when, and at what cost. Van der Zwaan 2004 (The learning potential of photovoltaics: implications for energy policy, Energy Policy 32 (2004) 1545–1554) includes many useful cost estimates of the learning investment needed to make solar PV economically competitive (on the order of $100-200 bn) that could be featured prominently in this chapter. (Donald Pols, Friends of the Earth Netherlands/Milieudefensie)	Accepted
4-49	B	54	19	54	19	Solar "technical potential" of 1600 EJ/yr. The "technical potential" of solar is more than two orders of magnitude smaller than 1600 EJ/yr, if technologies for large scale storage cannot be developed. Even with storage, land and other resource requirements are likely to limit solar energy's contribution to 10-15% of the so-called "technical potential" (See Green, Baksi, and Dilmaghani, "Challenges to a Climate Stabilizing energy Future" , Energy Policy, In Press (likely publication date December, 2006) U.S. Government (Government of U.S. Department of State)	Noted
4-1232	A	54	22	54	29	The updated number for total installed capacity as of the end of 2005 is 5000 MWp (Greenpeace/EPIA - attached) (Steve Sawyer, Greenpeace International)	Accepted – will be included
4-1233	A	54	25	54	25	Again autonomous growth does not show market penetration in a good way. Growth in market share is a better indicator. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Noted
4-50	B	54	28	54	0	"…(Maycock, 2003)" - 2003 reference for 2005 data U.S. Government (Government of U.S. Department of State)	Noted
4-1234	A	54	31	54	31	Need to state what base the 30% is growing from in developing countries as well as the actual base of PV new capacity growth (John Kessels, Energy Research Centre of the Netherlands)	Noted
4-51	B	54	39	54	0	"…a 20%...on average" U.S. Government (Government of U.S. Department of State)	Accepted
4-1235	A	54	40	0	0	Can delete "well"	Accepted

						(Danny Harvey, University of Toronto)	
4-1236	A	54	45	0	0	You may want to check for a wider source of information for solar PV costs. The data the IEA has suggests modules cost around USD 3.5/watt, but the average installled cost for abuilding-intergrated grid-connected PV system is more like USD 5-6/watt in IEA countries, with consequently higher electricity prices. Not many systems in IEA countries could produce at USD 0.20-0.30/kWh (see IEA 2004, Renewable Energy: Market and Policy Trends in IEA Countries). (Michael Taylor, International Energy Agency)	Accepted
4-52	B	54	45	54	46	ALL LCOE calculations-ignore; finance terms to get LCOE. Need to specify U.S. Government (Government of U.S. Department of State)	Noted
4-1237	A	55	1	55	3	Is this a consistent or reasonable scenario, jumping from 1% in 2020 to 20% in 2040, especially when the base also grows? Give the required compounded annual growth rate. (Danny Harvey, University of Toronto)	Noted
4-53	B	55	3	55	3	2040 over 20 % of global electricity from PV: this number is not plausible and contradicts the effort to design a cost-efficient mitigation path. (Government of Germany)	Noted
4-1238	A	55	6	55	14	What is this paragraph referenced from (John Kessels, Energy Research Centre of the Netherlands)	Accepted – ref. will be added
4-54	B	55	7	55	0	"Mention of Si material shortage? New stock supply plants (Wacker, etc.?)" U.S. Government (Government of U.S. Department of State)	Noted
4-55	B	55	7	55	11	"diselenid" should be spelled "diselenide." Commercial thin fill cell efficiencies are currently 11%, not 8%. Most importantly, the use of "37% for super thin flexible cells" is confusing since this terminology does not exist. The only cells that have reached 37% efficiency are III-V cells (gallium arsenide-based cells), which are used for terrestrial PV concentrators. This term should be checked and corrected, depending on what the author means. U.S. Government (Government of U.S. Department of State)	Noted
4-1239	A	55	18	55	18	The potential marine energy resource is huge…" again a vague statement, and one that seems to be contradicted by its own reference. Table 4.3.1 shows 7 EJ/a (second lowest of the renewable resources). (Christine Copley, World Coal Institute)	Accepted – will be checked

4-56	B	55	18	56	19	The discussion of Ocean Energy refers to the Table 4.3.1 entry of 7 EJ but then never explains it in terms of the categories of Ocean Energy (Wave Energy, Marine Currents, and Ocean Gradients). The discussion would be improved by stating the assumed values of resource base and cost for all three types of Ocean energy. U.S. Government (Government of U.S. Department of State)	Accepted
4-1240	A	55	19	55	32	Shorten this paragraph, (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-1241	A	55	25	55	25	The Rance river dam, in France, has delivered 600 GWh of electric power per year, since 1967 ! (Government of France)	Noted
4-1242	A	55	26	0	0	Unfortunately, the possibility of a Severn estuarine barrage has once more been broached (it was first mooted in 1849), with the Leader of the Welsh National Assembly considering it an excellent idea "despite the cost to wildlife". The Royal Society for the Protection of Birds (UK) is "strongly opposed to barrages on any estuaries" (the UK has an important international position in its estuaries for harbouring migratory and over-wintering birds). Electricite de France concluded that its La Rance barrage near St. Malo "caused the almost complete disappearance of the original species". (Michael Jefferson, World Renewable Energy Network & Congresses)	Accepted
4-57	B	55	26	55	27	“Seems too small to be commercial” U.S. Government (Government of U.S. Department of State)	Noted
4-58	B	55	40	55	0	Financing terms? U.S. Government (Government of U.S. Department of State)	Noted
4-1243	A	56	0	56	0	Figure 4.3.13 Remember to add the "legend" (José Somoza, National Institute of Economic Research)	Accepted
4-59	B	56	2	56	2	Generating costs of 0.35 to 0.62 Ct/kWh seem to contradict p 52 l 26 (Government of Germany)	Noted
4-1244	A	56	4	56	13	Please update your information: there is a tidal power plant at work in France since 1967… (Usine marémotrice de la Rance) and a couple of others elsewhere in the world. (Cédric PHILIBERT, International Energy Agency)	Noted

Comments on section 4.3.3.2 (Wind) Joergen

4-1004	A	39	18	0	0	"Section 4.3.3.2 Wind": "Section 4.3.3.2 Wind" The Wind energy figures should be updated to 2004 (see specific comments). Many of the statements in the section are undocumented and uses several notions not found in common sector literature and scientific journals. The paragraph stresses and exaggerates minor issues, while downplaying the potentials of having an energy source that is close to being cost competitive to any other electricity generating technology. Undocumented references include, e.g.: i) it talks of "an additional cost burden of wind energy in Denmark to provide reliability" – a term I have never seen used and would like to know what means; ii) it mentions public objections (without any reference) as a main barrier to both current and future development, despite the fact that wind energy consistently scores approval ratings of 70-80% in opinion polls all over the world – the highest, together with solar, of any electricity technology. In Denmark, the country in the world with the largest number of wind turbines per sq.km. 96% of the population has a positive attitude to wind energy. A study poll conducted by AC Nielsen from 2006 showed that 91% of the Danish population support an increasing share of wind energy, 5% said the current level is sufficient while 1% believed there were already too many wind turbines. Thus it is directly wrong when the section indicates that public perception is a main constraint.; iii) it mentions an often quoted myth that wind energy faces dramatic barriers beyond penetration levels above 20%. The reality is that most electricity systems in the world can accommodate wind energy up to 20% without making any significant changes to current infrastructure. Beyond 20%, depending on the individual system, it may be necessary to make adjustments, but "accurate forecasting", "demand side response measures" and "storing" are not needed, as documented in numerous studies, to increase wind power penetration beyond 20%. The International Energy Agency concluded in its report "Variability of wind power an other renewables that "the experience with wind power showed that integration was more an economic and political issue than a technical issue" and gave as an example of the economics that the additional system cost for 20% wind and biomass scenario in UK was €0.44/MWh, or less than 1% of generation cost of power. Furthermore, any cost estimation of balancing and reserve capacity must include a comparison to other technologies. A recent report from the UK Energy Research Centre comes to similar conclusions as the IEA - see http://www.ukerc.ac.uk/content/view/11/86/ -	Accepted: figures updated Accepted: block deleted Accepted: text modified Accepted: text modifies

						and compares the cost of wind power variability to that of gas. It says: "If wind power were to supply 20% of Britain's electricity, intermittency costs would be 0.5 - 0.8p per kilowatt an hour (p/kWh) of wind output. This would be added to wind generating costs of 3 - 5p p/kWh. By comparison, costs of gas fired power stations are around 3p p/kWh.The impact on electricity consumers would be around 0.1p p/kWh. Domestic electricity tariffs are typically 10 - 16p p/kWh. Intermittency therefore would account for around 1% of electricity costs". If the IPCC report wants to make a big issue out of the complex subject of variability, it should get a better understanding of the facts. I warmly recommend to read the above report from IEA as wells as EWEA's publication "Large scale integration of wind energy in the European power supply: analysis, issues and recommendations (December 2005)" – see http://www.ewea.org/index.php?id=178 iv) There is no "trend to replace older and smaller turbines". It has only happened in Denmark at any significant scale. In summary, the section on wind has many positive, and well documented elements, but when it comes to describing some of the barriers too wind, it looses credibility by introducing notions that are undefined in wind power literature or by airing myths without referencing supporting documentation. See additional comments. (Christian Kjaer, European Wind Energy Association)	Accepted: text changed
4-1005	A	39	18	41	18	The discussion of wind power cites public objections due to the "perceived visual impacts." However, it does not mention the environmental issues associated with birds, bats, and land, other than an inclusion of birdstrikes in a list on line 40 of issues that are "better understood." For wind energy, the most significant environmental concern relates to the death of birds and bats resulting from collisions with wind turbine blades. A 1992 California Energy Commission study estimated than more than 1,766 bats and 4,721 wild birds (including more than 40 species) die per year at the Altamont Pass Wind Resource Area, where more than 5,400 wind turbines operate. Several studies conducted in the Appalachian Mountains (focused on the region from Tennessee toVermont) have found that large numbers of nocturnal migrants (including bats) are uniquely at risk of colliding with wind turbines. Some wind farms operating in Tennessee and California have experienced 'kills' of up to forty-eight bats per turbine annually. The number of avian deaths could be especially large over the	Accepted: Paragraph modified.

						much of the eastern U.S. if wind turbines were operated during the migration season In Virginia, during the migration season, more than 1.7 million birds per night fly over the state. Additionally, wind farms are sometimes highly land intensive. At the Mountaineer Wind Energy Center in West Virginia, for instance, more than forty acres of forest were bulldozed and 150 acres of forest-interior were lost to erect eight turbines. Similarly, 350 acres of forest habitat were destroyed to construct twenty wind turbines at a Meyersdale, Pennsylvania, windplant. One recent study found wind turbines are the most land intensive form of electricity generation, since they need approximately 500 acres to generate 200 MW of power. In contrast, a typical power plant involving simple cycle combined cycle turbines (burning fossil fuel) requires approximately 25 acres of land to produce around 200 MW of power. Yet the 4.3.3.2 Text, Table 4.3.1 mention only "perceived visual impacts" (as if there were any other kind of visual impacts) as the environmental concern associated with wind.. There is a legitimate basis for concern that widespread use of wind energy could have profound impacts on regional, national and world populations of both birds and bats. This environmental concern should be mentioned. U.S. Government (Government of U.S. Department of State)	
4-1006	A	39	20	39	24	The paragraph should be updated with the latest figures 2004 figures from the Global Wind Energy Council. Furthermore, it makes little sense comparing to joule when measuring wind, hydro and nuclear and if it is done, a reference to total potential should be made. Consequently, the common reference should be electricity (TWh) as it is the case with the nuclear section (4.3.2 Nuclear energy on page 30). That would insure better consistence between the sections. Given the above, the paragraph should be changed to: "The global theoretical potential of the wind energy resource is estimated at 6,000 EJ/year (Johansson et al., 2004), equal to 1.7 million TWh or more than 100 times the global electricity production of 16,074 TWh in 2002 (IEA, 2004a). The technical potential is estimated at 600 EJ/year (166,667 TWh) or ten times the global production of electricity. Global installed capacity of wind power increased from 2.3 GW in 1991 to 59.1 GW at the end of 2005. The 59.1 GW will, in an average wind year produce app. 120 TWh of electricity equal to 0.75% of global electricity production. The European Union had 40.504 MW of installed capacity at the end of 2005, which meets 2.8% of EU electricity demand in a normal wind	Accepted: New reference with 2005 data included and text modified

						year. [source: http://www.ewea.org/fileadmin/ewea_documents/documents/press_releases/2006/060201_Statistics_2005.pdf]. New wind installation capacity……] (Christian Kjaer, European Wind Energy Association)	
4-1007	A	39	20	39	24	The figures are inconsistent for the share of wind because the IAE figures quoted were not updated. For a production in 2004 of 95 TWh of wind electricity as quoted in the next sentence, the world proportion of wind power is just 1% and not 0,6% as quoted. More recent figures for 2005 such is industry journal "Windpower Monthly" show even higher growth in 2005. Suggestion : remove the second sentence "Wind provided only around 0,6%..." Add new sentence after third "it generated 95TWh (GWEC, 2005) at an average capacity factor of around 23%." then additional sentence : "This makes already the contribution of wind slightly over 1% of the world supply." (ANTOINE BONDUELLE, Université Lille II)	Accepted: Data updated
4-1008	A	39	21	39	22	Please check other statistics as well. The World market Update 2005 from BTM Consult (ISBN 87-987788-8-9), which is to be regarded a reliable source of information speaks about 0,69% of the world's electricity generation, which is 17512 TWh (with reference to IEA World Energy Outlook 2004!) (Theo J. de Lange, Energy research Centre of the Netherlands ECN)	Accepted: reference included
4-1009	A	39	21	39	22	Are there no more recent data that from 2002? ' ...Wind provided only around 0.6% of the 16,074 TWh global electricity production in 2002 (IEA, 2004a). ...' As the development of wind is very dynamic the most recent data are desired. (Manfred Treber, Germanwatch)	Accepted: new data provided
4-1010	A	39	21	0	0	Use data for 2004 from IEA or BP, 2002 is a little out of date. Please contact me if you don't have access to the latest IEA statistics or see our website (www.iea.org). (Michael Taylor, International Energy Agency)	Accepted: new data provided
4-1011	A	39	22	39	23	Please update statistics with available sources for 2005 . The IEA mentions in their IEA Wind Energy Annual Report 59,2 GW in 2005 . See also Wind Power Monthly (world statistics issue, April 2006) and the World market Update 2005 from BTM Consult (ISBN 87-987788-8-9). (Theo J. de Lange, Energy research Centre of the Netherlands ECN)	Accepted: new data provided
4-1012	A	39	23	29	23	The updated numbers for 2005 are 59 GW installed capacity and 124 TWhrs were produced. See GWEC 2006(attached)	Accepted: new data provided

						(Steve Sawyer, Greenpeace International)	
4-1013	A	39	23	0	0	Update to the end of 2005 (or 2006 if possible) before going to press. (Danny Harvey, University of Toronto)	Accepted: new data provided
4-1014	A	39	26	39	27	Change sentence to "By the end of 2005, 680 MW of offshore wind capacity was installed globally (all in Europe), with the expectation……." (Christian Kjaer, European Wind Energy Association)	Accepted: new data provided
4-1015	A	39	26	39	28	This sentence seems to imply that wind capacity will "grow rapidly" because wind speeds will increase. This sentence should be rewritten. U.S. Government (Government of U.S. Department of State)	Accepted: text changed
4-1016	A	39	27	39	27	Offshore wind capacity reached 679,8 MW by the end of 2005. See BTM Consult, World Market Update 2005 (ISBN 87-987788-8-9) (Theo J. de Lange, Energy research Centre of the Netherlands ECN)	Accepted: new data provided
4-1017	A	39	27	39	27	Not only higher mean annuyal wind speeds, but also lower public objections! (Theo J. de Lange, Energy research Centre of the Netherlands ECN)	Rejected
4-1018	A	39	27	0	0	750 MW (Gerard van Bussel, Section Wind Energy, Faculty LR, TU Delft.)	Rejected: No reference
4-1019	A	39	28	0	0	Can delete "as" (Danny Harvey, University of Toronto)	Accepted: sentence deleted
4-1020	A	39	30	39	37	Chap 4, p39, lines 30-37: Delete whole paragraph, because it describes a singular situation in a very small grid with biased literature. More recent reports from Denmark show decreased general electricity prices due to wind power production resulting in a situation with no extra costs of WE in Denmark compared to a conventional supply. But a far better example is the operational experience with 18 GW Wind Power in Germany. Reference: dena-Grid-Study (2005): "Integration into the national grid of onshore and offshore wind energy generated in Germany by the year 2020" http://www.dena.de/page/fileadmin/DeNA/dokumente/Programme/Kraftwerke_Netze/dena_Grid_Study_Summary_2005-03-23.pdf Add: "The costs of regulative power decrease drastically with a) the spatial size of the grid b) the size of the area with distributed wind turbines and c) with the share of hy-dropower and flexible, natural-gas fired power plants." Compare: Morthorst, P.E., Wind power: Status and perspectives. In: Future electricity technolo-gies and systems. Jamasb, T.; Nuttall, W.J.; Pollitt, M.G. (eds.), (Cambridge University Press, Cambridge, 2005) (Department of Applied Economics Occational Papers,	Accepted: block deleted Accepted: Text and references added.

						no. 67) Chapter 3 Ackermann, T.; Morthorst, P.E., Economic aspects of wind power in power systems. In: Wind power in power systems. Ackermann, T. (ed.), (Wiley, Chichester, 2005) Chapter 18 (,)	
4-1021	A	39	30	39	30	Is the 18.5 % figure relative to the installed power or to the actual energy production? (Government of France)	Noted: Text has bbeen deleted
4-1022	A	39	30	39	37	Replace text with the following: "Wind energy has been promoted for years in Denmark and in 1999 the parliament set a goal for 20 percent of electricity from renewables. This has largely been accomplished. The Western Denmark grid has been run by Eltra, while the Eastern Grid has been run by Elkraft System Both were combined into Energinet.dk in 2005. Much of the wind capacity is installed on the Eltra grid. Statistics for 2002 are (Christensen 2003) as follows: Thermal generation 3100 MW, combined heat and power (CHP) 1000 MW, and Wind 2300 MW. This is compared to a minimum load of 1190 MW and peak load of 3700 MW. In 2002, Wind provided 18.2 percent of total generation while CHP provided 32%. Both wind and CHP are considered "must-take" and are not controlled. With a minimum load of 1190 MW, there are many times when the level of wind production and CHP exceed the Eltra load, and Eltra sells excess to the power pool. Eltra has ties to Norway, Sweden and Germany. Even though wind provides18.2 percent of annual generation, the hourly penetration, defined as the ratio of wind power to load, can approach 60 to 120 percent, far larger than the current wind penetration on any other system in the world. Eltra accommodates this large penetration by adding reserve generation capacity to accommodate variations in wind output not able to be compensated by the market and by various wind plant forecasting techniques to assist in market projections. It is estimated that this balancing reserve cost Eltra 67.5 million DKK in 2002 or $11.5 million USD. This amounts to 19.5 DKK per MWh or 3.3$/MWh equivalent to 3.3 mills per kWh. (System Report 2003, page 57). This balancing cost is generally consistent with costs of integrating wind in US studies of 2 to 5 mills/kWh at penetrations up to 15 to 20 percent (Zavadil 2005).Eltra management plans to avoid use of tie lines to provide regulation by implementing grid upgrades and a cell-like grid structure, price sensitive distributed generation and storage, price sensitive CHP (now that	Rejected: Too much detail

						CHP is no longer "must take"), photovoltaics, and hydrogen (in time). (Bach 2005)" References:Eltra, System Report 2003, Paul-Frederik Bach, Experience with Integrating Wind Energy in Western Denmark, Eltra, presented at AWEA Wind Power Transmission workshop, Toronto, March 30, 2005.Zavadil, Robert, Wind Generation and Operating Impacts, EEI Wind Energy WorkshopWashington, DC April 4, 2006 U.S. Government (Government of U.S. Department of State)	
4-1023	A	39	31	39	32	Did this large investment permit Denmark to be well off with its emissions reduction commitments ? (Government of France)	Noted: Paragraph deleted
4-1024	A	39	32	39	37	The paragraph is based on an article in a Danish weekly newspaper, claiming that 70.5% of the Danish electricity production was exported and, consequently, that only 6% of the Danish consumption was met with wind energy. The claim is untrue, bordering ridiculous. The article contains no reference to any person, institution or study to back the claim. The only reference the journalist makes is the following (translated fro Danish): "The calculation is based on the assumption that Denmark uses the electricity production from coal, gas and biomass before wind energy". This is technically incorrect and the complete opposite situation of what happens in Danish electricity production (and any other area using wind power). Wind power is always dispatched first, because it has no fuel cost component and therefore has the lowest marginal cost (together with hydro, which Denmark does not have) of all power consumption. It is alarming that a draft IPCC report can contain a reference to a newspaper article in which the journalist, without backup from any sources, makes a technically incorrect claim without reference to any person or study. What is even problematic, though is that the draft IPCC report claims that the reason for the export of electricity was grid stability. Not even the technically incorrect article from Vestergaard makes that insane claim. As the UK Energy Research Centre concluded recently: "None of the 200+ studies UKERC reviewed suggested that the introduction of significant levels of intermittent renewable energy would lead to reduced reliability." - (see http://www.ukerc.ac.uk/content/view/258/852). The paragraph refers to another popular myth, that the "cost of reliability" (whatever that means? It is not a common notion in the scientific community) is high. We assume that notion refers to balancing and back-up costs. These have in numerous studies been documented	Accepted: Paragraph deleted

						to be minimal and lower than for other technologies, IEA and UK Energy Research Centre says 1% of electricity cost. Given that Denmark is the country with the highest share of wind power, a reference to the country is recommended. But is should reflect the actual situation in the country and not be based on undocumented calculations and claims. We suggest changing the paragraph to: "Denmark is the country in the world with the highest share of wind energy. In a normal wind year, wind energy meets 20.8% of the country's electricity demand. [source: http://www.dkvind.dk/materiale/vindens_energi/pdf/dec04.pdf]. It is estimated that wind energy saved Danish electricity consumers between 140 and 240 million DKK in 2004 and a larger amount in 2005 as a result of the downward pressure on power prices from wind energy's low marginal cost of 1.2-1.5 €cens/kWh. (see www.dkvind.dk/nyheder/leder0206.htm] In Spain, similar studies have documented that pool prices are reduced the wind power production increases. In some regions of Germany and Spain, wind energy meets 40% or more of electricity demand. The variability of wind energy has been the focus of many recent studies. The IEA and the UK Energy Research Centre puts these at 1% of electricity costs for a penetration level of 20%, and significantly lower than other technologies." (Christian Kjaer, European Wind Energy Association)	
4-1025	A	39	32	39	35	The first sentence is irrelevant and misleading and should be removed. It is not straightforward to calculate which energy production is the one that has been exported. As there are all the time exports and imports, it may well be that wind power is exchanged with Norwegian hydro power (export on windy days, import on calm days). One big reason for the export is that the thermal power is kept running despite windy days (that is, according to an average daily profile of wind on that month) so just by changing the power system operation routines would also change the amount of exports. The second sentence should be reformulated, to take the appropriate system operator TSO quote on the balancing costs: The additional cost burden of wind energy in West Denmark is estimated to 65 Million DKK for 3.3 TWh wind, that is about 2-3 euros per MWh (Eriksen, 2002). Eriksen, P. B., Pedersen, J., Parbo, H. 2002. Challenges of Large-Scale Integration of Distributed Generation into Eltra's System. In: Proceedings of 2nd International Symposium on Distributed Generation: Power System and Market Aspects, Stockholm, 2–4 October 2002.	Accepted: Paragraph deleted

						(Government of Finland)	
4-1026	A	39	34	0	0	This comment extends one made above, which seems to have been partially deleted: It seems not generally realised even in the UK, with its relatively good wind resource, that capacity figures vary from Northern Ireland's 36% and Scotland's 30% to 21% in North-East England, and expected to be below 20% in Central England (in some locations, well below). It makes good sense to focus on higher wind speed areas to obtain relatively good capacity factors, reasons including the easing of supply bottlenecks and speeding up of the planning process. (Michael Jefferson, World Renewable Energy Network & Congresses)	Noted
4-1027	A	39	34	0	0	Denmark's wind energy has been exported almost invariably at a loss. In 2004 84% of Denmark's wind energy was exported to Norway, thus substituting for hydropower with no net benefit in terms of CO2 emissions averted. The question of whether Germany has invested its resources wisely in wind energy should also be addressed here, given the alternatives (more energy efficiency, active and passive solar, biomass, and energy from wastes), since the Deutsche-Energie Agentur (a report backed by the German Ministry of Economic Affairs) has suggested its wind resource is so intermittent that although rated capacity may reach over 48 GW by 2020 it will only reliably sustitute for 2 GW of conventional capacity. This in part reflects the low capacity factors being achieved by wind turbines in much of inland Germany (CFs of 12-16% are not unusual, compared to 30% in Scotland and 36% in Northern Ireland). There are strong grounds for encouraging wind energy developments in higher wind speed areas, not least in order to relieve supply bottlenecks - in Germany, the UK, and elsewhere. It seems not generally realised that even in the UK, with a relatively very good wind resource, capacity factors range from 36% in Northern Ireland (as previously stated), to 21% in the North-East of England (and below 20% estimated for Central England). Cost estimates need to take such matters into account also, especially where few potential sites remain in higherwind speed areas. (Michael Jefferson, World Renewable Energy Network & Congresses)	Noted: Paragraph delete
4-1028	A	39	36	0	0	I am tending not to believe this figures at all. Who is this mr Vestergaard and what is the stature of the reference??. It seems to be something similar to a letter to the editor which cannot be taken as a proper reference with a solid technical or scientific background. What is the case in Denmark: Some areas in Denmark have a high penetration grade of wind power while the	Accepted: Paragraph deleted

						amount of people living there as well as the level of industrialization is limited. Thus situations where wind power production equals or sometimes exceed local demand exist. In order to keep stability and security of supply also other power stations are operation in parallel, and the amount of surplus is sold on the power exchange market. This can lead to temporarily low prices. But that in the end only 6% is used inside Dk cannot be true, given a generation contribution of 16.5%. I am sure there are proper referenced values available regarding the export of renewable energy out of Denmark. Unfortunately I do not have them readily available. I am afraid that also a well known mistake is made: 18.5% of electricity demand roughly equals 6% of the energy demand!! (Gerard van Bussel, Section Wind Energy, Faculty LR, TU Delft.)	
4-1029	A	39	39	39	40	The GHG emissions associated with the building of a wind farm including its concrete base is part of the overall GHG budget, and their value is relevant and should be given in an IPCC report. (Government of France)	Accepted, these emissions is included in a figure in ch.4
4-1030	A	39	44	39	44	Replace "50 kW" to "22 kW in the beginning of the 1980s" (Christian Kjaer, European Wind Energy Association)	Accepted: text added
4-1031	A	39	45	39	46	Wrong internet link refers to REPOWER instead to ENERCON (Nikolaus Supersberger, Wuppertal Institute for Climate Environment Energy)	Accepted: link name updated
4-1032	A	39	46	0	0	of 116 m. The largest wind turbines commercially available are the REPOWER 5 M turbines with a diameter of 126 m. Currently two of these windturbines are installed on an offshore site on the east coast of Scotland. (Gerard van Bussel, Section Wind Energy, Faculty LR, TU Delft.)	Accepted: text added
4-1033	A	39	46	39	46	The web reference refers to the Repower 5 MW instead of the Enercon 6 MW machine (Christian Kjaer, European Wind Energy Association)	Accepted: reference changed
4-1034	A	40	1	40	1	add "onshore", as the costs for an off shore wind farm will be higher (Theo J. de Lange, Energy research Centre of the Netherlands ECN)	Accepted: text changed
4-1035	A	40	1	40	3	The capital cost range for new wind projects is reasonable compared to prices experienced between 1998 and 2004 and compared to future prices that will be realized due to future learning and mass production, but is on the low side compared to current prices. In the past 2 years, the total costs for wind farms have ranged from $1400-$1800/kW in the US. The recent price increase is due to	Noted: data updated

						several factors including the current global shortage of wind turbines (driven in part by the US production tax credit extension); recent increases in steel, fuel and other commodity prices; exchange rates; and increased profit margins. We believe prices will come back down again as manufacturing capacity increases to catch up with demand. (Steve Clemmer, Union of Concerned Scientists)	
4-1036	A	40	1	40	3	The capital cost range for new wind projects is reasonable compared to prices experienced between 1998 and 2004 and compared to future prices that will be realized due to future learning and mass production, but is on the low side compared to current prices. In the past 2 years, the total costs for wind farms have ranged from $1400-$1800/kW in the US. The recent price increase is due to several factors including the current global shortage of wind turbines (driven in part by the US production tax credit extension); recent increases in steel, fuel and other commodity prices; exchange rates; and increased profit margins. We believe prices will come back down again as manufacturing capacity increases to catch up with demand. (Steve Clemmer, Union of Concerned Scientists)	Noted: data updated
4-1037	A	40	2	0	0	What do you mean by reducing grid access to less than 5 hours? You don't want wind generating into the grid for more than 5 hours??? (Michael Taylor, International Energy Agency)	(p41) Accepted: text deleted
4-1038	A	40	5	40	10	The costs from Morthorst are based on a series of assumptions within a standardized approach and do not reflect the actual level of costs in real life in Denmark. In addition, they do not reflect the additional costs which are given on page 39 (lines 35-37). The results mainly illustrate the decline in wind turbine costs over the year and not the actual level of costs. (Walter Ruijgrok, EnergieNed)	Rejected: line35-line37 deleted.
4-1039	A	40	5	0	0	You should mention the relationship between wind speed in m/s and capacity factors here somewhere. (Michael Taylor, International Energy Agency)	Noted
4-1040	A	40	7	40	7	"….(see Figure 4.3.3)….as has been the case…." May be the reference has to be made to Figure 4.3.5 and not 4.3.3. (Government of India)	Accepted: reference number changed
4-1041	A	40	10	40	15	Figure 4.3.5. Is there something wrong with the x-axis label here or do the data only run to 2001? If the data only run to 2001, it might be misleading to include these extra years to imply that these costs will continue to decline. If there are	Rejected

						more recent data, please include them in the graph as it would be instructive to see if this trend has continued. If the data set ends at 2001, the graph should also end at 2001. (James Dooley, Battelle)	
4-1042	A	40	16	0	0	???? Four continents have a real market, the fifth is emerging (South America) and still this is not seen as global??? (Gerard van Bussel, Section Wind Energy, Faculty LR, TU Delft.)	Accepted: text changed
4-1043	A	40	16	40	18	Wind energy is installed in more than 40 countries, so the first sentence is misleading. We suggest to change it to: "The wind energy sector is gradually becoming less reliant on the traditional markets of Germany and Spain. In 2005, the global market for wind turbines increased by more than 40% (Global Wind Energy Council; "Global Wind 2005 Report"), [see http://www.gwec.net/index.php?id=49] mainly driven by high growth in India and United States. Also Canada, China and Australia are increasingly turning to wind power as a means of diversifying energy supply, hedge against fossil fuel price risk and reduce greenhouse gas emissions. The Global Wind Energy Council (GWEC) expects the trend towards increased market diversification will continue to strengthen and has set a target of 1,250 GW……." (Christian Kjaer, European Wind Energy Association)	Accepted: text changed
4-1044	A	40	17	40	20	GWEC & EWEA are industry groups not regulatory ones, thus targets are not binding in any sense. The text suggests otherwise so should be amended. (Christine Copley, World Coal Institute)	Accepted: text changed
4-1045	A	40	18	40	18	Change set a target by promoting a target as concerns the European Wind Energy Association ; There is no prescription. (DELLERO Nicole, AREVA)	Rejected
4-1046	A	40	18	40	18	Change set a target by promoting a target as concerns the European Wind Energy Association ; There is no prescription. (DELLERO Nicole, AREVA)	See 4-1046
4-1047	A	40	19	40	20	EWEA increased their targetsfor Europe: 300 GW in 2030, of which 100 - 150 MW off shore. See the EWEA Briefing February 2006: "No Fuel - Europe's Energy Crisis - The No Fuel Solution. Please see their publication. The 2020 target from 1996 was reached in 2000 (conventional wisdom scenario) and 2004 (advanced scenario). The 2015 target, as set by the European Commission in 1999 has been reached by the and of 2004. Between 1996 and 2003, the Commission's estimate of how much wind power would be built in 2010 was increased ninefold!	Rejected: too much detail

						(Theo J. de Lange, Energy research Centre of the Netherlands ECN)	
4-1048	A	40	24	40	24	I am not sure what is meant by "global technical potential". In any event, the 72 TW seems much too high because to produce that amount of wind power for use would require from 35-45 million km^2 of land (depending on location)—or around 30% of all land in the world (not including Antarctica). However, the reference to a 20% capacity utilization factor on line 25 makes me think that the 72 TW is based on an impossible 100% capacity utilization factor. If instead, the real potential is ~14 TW (20% of 72 TW), then the land requirement would be about 8 million km^2—still several times more than the 1.2 million km^2 that the TAR (Ch 3) suggested might be available. Moreover, the "technical potential" of solar is not meaningful without large scale storage. Incidentally, I think that Jacobsen (who I believe is the source of the 72 TW figure) derives, in his model, a much higher (and much less credible) capacity utilization factor (~45%). (Christopher Green, McGill University)	Noted: text changed
4-1049	A	40	24	40	26	Wind, on potential, the section does mention a potential exceeding world energy consumption, but why not include a more detailed discussion on regional potentials?. The most comprehensive study on global wind potential to date (Archer & Jacobson 2005:JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 110, D12110, doi:10.1029/2004JD005462, 2005) is mentioned only with a web reference (!), and the potential of 625 TWh is here in the SOR downgraded by a factor of five to 126,000 TWh – which seems a result of applying a capacity factor of 20% instead of a mistakenly assumed 100% (capacity factor 48% in the study). (Donald Pols, Friends of the Earth Netherlands/Milieudefensie)	Noted
4-1050	A	40	24	40	24	It is not clear what is meant by "global technical potential". In any event, the 72 TW seems much too high because to produce that amount of wind power for use would require from 35-45 million km^2 of land (depending on location)—or around 30% of all land in the world (not including Antarctica). However, the reference to a 20% capacity utilization factor on line 25 implies that the 72 TW is based on an 100% capacity utilization factor that is not possible. If instead, the real potential is ~14 TW (20% of 72 TW), then the land requirement would be about 8 million km^2—still several times more than the 1.2 million km^2 that the TAR (Ch 3) suggested might be available. Moreover, the "technical potential" of solar is not meaningful without large scale storage. Incidentally, it is thought that Jacobsen (believed to be the source of the 72 TW figure) derives, in his model, a much higher (and much less credible) capacity utilization factor (~45%). U.S.	Noted

						Government (Government of U.S. Department of State)	
4-1051	A	40	25	40	26	A 20% average capacity factor for wind is unrealistically low. While this is representative of some old projects installed in lower quality resource areas, new projects in the US have capacity factors ranging from 30-45%. EIA, DOE, and the National Renewable Energy Lab all project capcity factors to continue to increase. Thus, I would suggest using an average capacity factor of 35%. (Steve Clemmer, Union of Concerned Scientists)	Accepted
4-1052	A	40	25	40	26	A 20% average capacity factor for wind is unrealistically low. While this is representative of some old projects installed in lower quality resource areas, new projects in the US have capacity factors ranging from 30-45%. EIA, DOE, and the National Renewable Energy Lab all project capcity factors to continue to increase. Thus, I would suggest using an average capacity factor of 35%. (Steve Clemmer, Union of Concerned Scientists)	See 4-1051
4-1053	A	40	25	0	0	Some idea of the land area required for such a lrage number of wind turbines would be worth mentioning. My gut feeling is that there will be incerasing problems in expanding capacity in many OECD countries at some point. (Michael Taylor, International Energy Agency)	Accepted: text changed
4-1054	A	40	27	41	7	The content should be rewritten, starting from line 27 "The actual utilization…." to page 41 line 6. The section implies that development will be hampered by public acceptance which there is no documentation for, on the contrary (see the general comments to section 4.3.3.2. A summary of the various opinion polls on wind energy can be found in at: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/WD/WD22vi_public.pdf The section also mentions an often used myth that wind energy faces dramatic barriers beyond penetration levels above 20%. The reality is that most electricity systems in the world can accommodate wind energy up to 20% without making any significant changes to current infrastructure, and some already do (Denmark and areas of Germany and Spain). We suggest deleting all content and replace it with: “In opinion polls, wind energy consistently enjoys support from 70-80% of the populations. In a 2002 German opinion poll, 86% of the population were in favour of increasing wind power’s contribution to the energy mix. Surveys also show that local approval rises once a wind farm starts operating, and is increased with local	Noted: text changed

						involvement and good planning guidelines and integration into the landscape. In Denmark, the country in the world with the largest number of wind turbines per sq.km., 96% of the population has a positive attitude to wind energy. A study poll conducted by AC Nielsen from 2006 showed that 91% of the Danish population support an increasing share of wind energy, 5% said the current level is sufficient while 1% believed there were already too many wind turbines. The survey also revealed that people living close to wind turbines are more in favour of wind turbines than people that live at a distance from them. Most electricity systems in the world can accommodate wind energy up to 20% without making any significant changes to current infrastructure. Beyond 20%, depending on the individual system, it may be necessary to make adjustments in the way the grid is operated, given that most grids in the world have been designed for large centralised power plants. Several studies have documented that there is sufficient back-up capacity in electricity systems to integrate large amounts of wind power. The International Energy Agency concluded in its report "Variability of wind power an other renewables that "the experience with wind power showed that integration was more an economic and political issue than a technical issue" and gave as an example of the economics that the additional system cost for 20% wind and biomass scenario in UK was €0.44/MWh, or less than 1% of generation cost of power. A recent report from the UK Energy Research Centre comes to similar conclusions as the IEA [see http://www.ukerc.ac.uk/content/view/11/86/] and compares the cost of wind power variability to that of gas. It says: "If wind power were to supply 20% of Britain's electricity, intermittency costs would be 0.5 - 0.8p per kilowatt an hour (p/kWh) of wind output. This would be added to wind generating costs of 3 - 5p p/kWh. By comparison, costs of gas fired power stations are around 3p p/kWh. The impact on electricity consumers would be around 0.1p p/kWh. Domestic electricity tariffs are typically 10 - 16p p/kWh. Intermittency therefore would account for around 1% of electricity costs". (Christian Kjaer, European Wind Energy Association)	
4-1055	A	40	27	0	0	You should also discuss Hoogwijk et al. (2004), who assessed the global wind energy potential assuming 2001 technology. They find the technical potential to be 6-7 times total present world electricity production, at a cut-off cost of $1/kWh (that is, not considering any potential where the cost is greater than $1/kWh). At a cut-off cost of 7 cents/kWh, they find the world potential electricity production	Noted

						with wind to be about equal to present total world electricity production. REFERENCE: Hoogwijk, M., de Vries, B. and Turkenburg, W. 2004. "Assessment of the global and regional geographical, technical and economic potential of onshore wind energy", Energy Economics 26:889-919. (Danny Harvey, University of Toronto)	
4-1056	A	40	29	40	32	In the first sentence "intermittent" should be replaced by "fluctuating" and the last part of the sentence "and the amount of back-up needed" should be removed. Large scale wind power dispersed over a power system area is not intermittent as even in extreme cases the power output reduction during one hour is below 30 % of installed capacity (Holttinen, 2004). Since wind is primarily an energy – not a capacity – source, no additional generation needs to be added to provide back-up capability provided that wind capacity is properly discounted in the determination of generation capacity adequacy (UWIG, 2006). In the second paragraph part of the conditions listed are not required at 20 % wind penetration. Suggested reformulation: "Generally, the impacts of wind power's variability and uncertainty on power system reliability and costs can be managed through proper plant interconnection, integration, transmission planning, and system and market operations (UWIG, 2006). To supply over 20% of a total grid's demand from wind power requires accurate forecasting, increases in the use of operational reserves in the power system and requires grid codes to enable wind power to be part of the power system (Fault-Ride-Through, Voltage control) (Eriksen et al, 2005; Holttinen, 2004). With demand side response measures, connections with other grid systems and a means of storing surplus energy the wind-energy of a power system could be enabled to meet very large fractions of total electricity demand (EWEA, 2005; Mazza and Hammerschlag, 2003)". www.uwig.org, Utility Wind Integration State of the Art by Utility wind integration group UWIG. Holttinen, H, 2004. The impact of large scale wind power production on the Nordic electricity system. VTT Publications 554. Espoo, VTT Processes, 2004. 82 p. + app. 111 p. http://www.vtt.fi/inf/pdf/publications/2004/P554.pdf. Eriksen, P B, Ackermann, T, Abildgaard, H, Smith, P, Winter, W, Garcia, J R, 2005. System operation with high wind penetration. The transmission challenges of Denmark, Germany, Spain and Ireland. IEEE power & energy magazine, nov/dec 2005. (Government of Finland)	

4-1057	A	40	32	40	32	The idea the grid could accommodate up to 20% of its load directly from wind energy needs to be put to rest. From what I understand, it is an old, theoretically derived estimate from Michael Grubb. Why not rely on experience. Contrary to popular thinking Denmark, as the Chapter notes (p.39), derives 6.0% of its electricity consumption, not the ~20% of its electricity production, from wind. In its wind energy production, Denmark is fortunate to be backed up by hydro power from Norway and Sweden and it also has the huge German market available. Thus Denmark's wind production experience cannot be repeated in many places in the world—at least not without large scale storage. Experience suggests that the stability of the grid is at risk if more than a few percentage points of its load is provided directly to it by intermittent sources. It is true that a somewhat better percentage (perhaps 10% or somewhat better) can be achieved if wind is backed up by large scale hydro (the most flexible of baseload sources). But reports are that even 10% has taxed the flexibility of US Pacific Northwest power companies that derive almost all of their power from run-of-the-river hydro. (Christopher Green, McGill University)	Rejected
4-1058	A	40	32	41	1	delete "and somewhat unpredictable", add: "On the other hand, Denmark, Germany, the US and Spain have good experiences with short-term wind power forecasting. See e.g.: (1) Gregor Giebel et al. Wind Power Prediction using Ensembles. Risø National Laboratory, ISBN 87-550-3464-0, September 2005, 43 p. (2) http://anemos.cma.fr." (,)	Accepted: text changed
4-1059	A	40	32	41	6	The chapter on wind power seems to treat this power source as a stand alone application. However, at page 40 line 33 the more random nature of this energy form is mentioned. This should be more emphasized. Wind power require a backup capacity when the wind is not blowing. Hydropower is a renewable with no or very low emissions of GHG (in an LCA perspective), it is easy to regulate and has a very short response time. One should therefore investigate into and point to the possibilities of how a closer combination of wind and hydropower (to some degree also gas power) will work in concert to mitigate GHG emissions. More hydropower will probably help to stabilize the power system and allow a greater penetration of wind power. The need for storage mentioned in line 5 & 6 page 41 could many places probably be met by hydropower reservoirs. Research initiatives have been launched in the past few years, to assess the potential of hybrid hydro/wind systems (IEA, 2006b).	Accepted: text changed

						(Tormod André Schei, Statkraft AS)	
4-1060	A	40	32	41	3	The idea the grid could accommodate up to 20% of its load directly from wind energy needs to be put to rest. From what is understood, it is an old, theoretically derived estimate from Michael Grubb. Why not rely on experience. Contrary to popular thinking Denmark, as the Chapter notes (p.39), derives 6.0% of its electricity consumption, not the ~20% of its electricity production, from wind. In its wind energy production, Denmark is fortunate to be backed up by hydro power from Norway and Sweden and it also has the huge German market available. Thus Denmark's wind production experience cannot be repeated in many places in the world—at least not without large scale storage. Experience suggests that the stability of the grid is at risk if more than a few percentage points of its load is provided directly to it by intermittent sources. It is true that a somewhat better percentage (perhaps 10% or somewhat better) can be achieved if wind is backed up by large scale hydro (the most flexible of baseload sources). But reports are that even 10% has taxed the flexibility of US Pacific Northwest power companies that derive almost all of their power from run-of-the-river hydro. Suggest IPCC recognize no technical consenses exists and the issue continues to be area of technical study. U.S. Government (Government of U.S. Department of State)	See 4-1057
4-1061	A	40	32	41	6	Replace text with the following:"There is no magic number, often quoted as 20% as the ratio of wind capacity to conventional capacity, above which wind integration is not possible. Instead the related cost of ancillary services, including balancing and reserve, increases with increasing penetration. The notion of a penetration limit – whether defined as a capacity ratio or annual energy -- becomes a question of the overall economics of the wind plants and the host power system (Holtinnen 2004, 2004a). US studies have shown that the ancillary service impacts of adding wind at levels of up to 15% to 20% penetration cost between $2 to $5/MWh (Zavadil 2005). Several studies of adding 20 percent annual energy are underway that will result in instantaneous capacity penetrations much higher than 20 percent. The key to minimizing impacts is to have large balancing or control areas and flexible generation (fast ramp rate and quick start up) to accommodate variations in aggregate wind power output. Significant improvements in wind forecasting that will assist in larger penetrations are expected as experience is gained with wind. Dedicated energy storage would assist in higher penetrations but is not necessary." References: Hannele Holttinen, "The impacts of hourly variations of large scale	Noted

						wind power production in the Nordic countries on the system regulation needs", VTT, http://www.uwasa.fi/itt/teti/sahko/NEPF/vasa_nordiskvind.ppt. Hannele Holttinen, 2004, "The impact of large scale wind power production on the Nordic electricity system", PhD report, http//www.vtt.fi/inf/pdf/publications/2004/P554.pdf Zavadil Robert, "Wind Generation and Operating Impacts", EEI Wind Energy WorkshopWashington, DC, April 4, 2006 U.S. Government (Government of U.S. Department of State)	
4-1062	A	41	1	41	3	The idea the grid could accommodate up to 20% of its load directly from wind energy needs to be put to rest. From what I understand, it is an old, theoretically derived estimate from Michael Grubb. Why not rely on experience. Contrary to popular thinking Denmark, as the Chapter notes (p.39), derives 6.0% of its electricity consumption, not the ~20% of its electricity production, from wind. In its wind energy production, Denmark is fortunate to be backed up by hydro power from Norway and Sweden and it also has the huge German market available. Thus Denmark's wind production experience cannot be repeated in many places in the world—at least not without large scale storage. Experience suggests that the stability of the grid is at risk if more than a few percentage points of its load is provided directly to it by intermittent sources. It is true that a somewhat better percentage (perhaps 10% or somewhat better) can be achieved if wind is backed up by large scale hydro (the most flexible of baseload sources). But reports are that even 10% has taxed the flexibility of US Pacific Northwest power companies that derive almost all of their power from run-of-the-river hydro. (Christopher Green, McGill University)	see 4-1057
4-1063	A	41	2	41	2	It is unclear what is meant by the phrase "….reducing grid access to <5 hours…" (Theo J. de Lange, Energy research Centre of the Netherlands ECN)	Accepted: text deleted
4-37	B	41	2	41	2	How is the number "reducing grid access to <5hours" justified? This seems unplausible. (Government of Germany)	Accepted: text deleted
4-1064	A	41	5	0	0	In some developing countries the wind potential and the potential o small rivers are not identified yet. To increase the participation of renewable resources in the energy mix is important develop programms to identifiy the potential of them. (Ramiro Juan Trujillo Blanco, National Programme on Climate Changes)	Noted
4-1065	A	41	6	0	0	Another option, which should be discussed here, is to use excess wind energy to recharge hot or cold thermal storage tanks in a district heating and cooling system.	Noted

						This permits the wind farm to be larger than it would be otherwise, thereby meeting a larger fraction of the non-district heating/cooling demand, while making use of some of the electricity that would otherwise be lost at times of peak winds, thereby reducing the economic penalty of oversizing. This option is discussed in Redlinger et la., 2002, Chapter 2). For a scenario in which 50% of Danish electricity demand in 2030 is met by wind, integrated operation of the electricity and heating systems cuts the wasted electricity production potential in half. REFERENCE: Redlinger, R.Y., P.D. Andersen, and P.E. Morthorst. 2002. Wind Energy in the 21st Century: Economics, Policy, Technology and the Changing Electricity Industry. Palgrave (Basingstoke), 245 pages. (Danny Harvey, University of Toronto)	
4-1066	A	41	7	0	0	A paragraph should be added here on published analyses of the feasibility and cost of baseload win energy systems. In particular, DeCarolis and Keith (2006) have assessed the cost of large-scale baseload wind power in the US. They considered a system consisting of the following components: one or five (geographically dispersed) wind farms in the central plains of the US; some combination of single cycle gas turbines, combined cycle gas turbines, and CAES as backup for when the wind power alone is unable to meet demand; and HVDC transmission corridors sized to meet some fraction of the wind farm(s) capacity. For current component capital costs, the direct cost of wind energy produced in western Iowa and transmitted to Chicago is 4.1 cents/kWh – about the same as for on all-gas baseline with natural gas at $4/GJ. This costs includes transmission cost and line losses but ignores intermittency. If wind is scaled up to supply 50% of the electricity demand, with some natural gas backup and some oversizing of the wind plant (and hence some wasted wind power), the average cost of electricity increases by 1.2 cents/kWh if there are five dispersed wind farms, and by 1.6 cents/kWh if there is only one wind farm. Denholm et al. (2005) have calculated the fraction of wasted wind energy as a function of the capacity factor for various wind systems with the ability to store 24 h of peak output power. For a 90% capacity factor (i.e., meeting 90% of baseload power demand), the spill rate is 15-45% for existing systems (having turbine capacity factors of 33-37% in regions with high winds) but 17% for a simulated future system (having a turbine capacity factor of 46%). Existing wind farms can	Rejected: Too much detail

						achieve a capacity factor >70% with <10% spill rate. REFERENCES: DeCarolis, J.F. and D.W. Keith. 2006. "The economics of large-scale wind power in a carbon constrained world," Energy Policy 34, 395-410. Denholm, P., G.L. Kulcinski and T. Holloway. 2005. "Emissions and energy efficiency assessment of baseload wind energy systems," Environmental Science & Technology 39, 1903-1911. (Danny Harvey, University of Toronto)	
4-1067	A	41	8	41	8	There is no general trend to replace older turbines. Only Denmark has successfully run a replacements scheme. The sentence should be rewritten to: "In Denmark, older and smaller wind turbines from the 1980s are being replaced by larger, more efficient……." (Christian Kjaer, European Wind Energy Association)	Accepted: text changed
4-1068	A	41	10	41	10	Change "More accurate aero-elastic models are being developed…." into "More accurate aerodynamic and aero-elastic models are being developed…." (Theo J. de Lange, Energy research Centre of the Netherlands ECN)	Rejected: no reference
4-1069	A	41	13	0	0	(on offshore turbines) significantly increased reliability and (Gerard van Bussel, Section Wind Energy, Faculty LR, TU Delft.)	Rejected: no reference
4-1070	A	41	15	0	0	Is necessary develop important efforts to modify the legal frame, to facilitate grant funds, others measures to achieve results in the wind sector. (Ramiro Juan Trujillo Blanco, National Programme on Climate Changes)	Rejected: no reference
4-1071	A	41	17	41	17	"….are around $US0.05-0.06/kWh….". Does this mean the cost of wind power or tariff in the regions? (Government of India)	Accepted: Text changed
4-38	B	41	19	41	19	add: and without considering external costs. (Government of Germany)	Rejected

Comments on section 4.3.3.3 (Biomass and bioenergy) Bernhard

4-1072	A	41	20	50	30	Considerable detail is given to bioenergy perhaps it could be reduced, for example the section on GHG Mitigation could be reduced to a couple of paragraphs as with many of the other sections (John Kessels, Energy Research Centre of the Netherlands)	Will shorten. Still to ensure that GHG mitigation is reduced to the minimum required, given the discussion in the BM CCT group

4-1073	A	41	20	50	30	With regard to cellulosic biomass, it's worth mentioning that integrating energy crop production with traditional agriculture can greatly increase the potential bioenergy supply. On a per acre basis, switchgrass can produce as much protein as soybeans (if not more). The RBAEF project has modelled several biorefining scenarios in which animal feed protein is co-produced with ethanol and other biofuels. (Lee Lynd, Dartmouth College)	Reject from view of ag chapter (Pete Smith). But consider this when writing the biorefinery text
4-1074	A	41	20	50	30	Regarding RD&D, technology transfer, and funding as these pertain to cellulosic biomass, I urge you to review NRDC's "Growing Energy" report (http://www.nrdc.org/air/energy/biofuels/contents.asp) and their list of policy recommendations (http://www.nrdc.org/air/energy/pump/contents.asp) (Lee Lynd, Dartmouth College)	Need to check out these links, and write a sentence about cellulosic.
4-1075	A	41	20	50	30	Rather amazing that ther is no mention of likely large research-driven advances that have yet to be realized. This is a critical point, as the difference between current and future mature technology is huge in terms of process efficiency and cost. When viewed through the lens of mature technology, biomass as a sustainable energy source emerges as a primary rather than bit player. (Lee Lynd, Dartmouth College)	Still need to address (not sure yet what to do)
4-1076	A	41	20	50	30	It would be useful to include a section entitled "Biomass feedstock supply and production". A recent article that discusses both is Hoogwijk et al., 2005; Biomass & Bioenergy, 29:225-257. NRDC's "Growing Energy" report discusses the U.S. situation. (Lee Lynd, Dartmouth College)	Already taken account of. We use this reference in Chapter 8.
4-1077	A	41	20	50	30	For a discussion of policy and potential impact of bioenergy, especially biofuels, please see NRDC's 'Growing Energy" report: http://www.nrdc.org/air/energy/biofuels/contents.asp (Lee Lynd, Dartmouth College)	Review this source
4-1078	A	41	20	0	0	Section is disproportionately long compared to other energy sources, and in significantly greater detail. Suggest there is plenty of scope for a succint summary! (Christine Copley, World Coal Institute)	Will shorten, but not as much as this reviewer likes, because bioenergy is much more diverse than, for example, coal. See also 1072
4-1079	A	41	22	41	0	What is “stockfeed?” not a term used in U.S. U.S. Government (Government of U.S. Department of State)	Deleted “stock”
4-1080	A	41	29	0	0	Should you mention electricity here as an energy carrier? (Michael Taylor, International Energy Agency)	Accept

4-1081	A	41	29	41	0	"include butanol (ethanol is not the ONLY gas-compatible biofuel" U.S. Government (Government of U.S. Department of State)	accept
4-1082	A	42	1	42	0	Figure 4.3.6. Under Waste.Chapter 10. Would request the box to read: "landfill gas and other biogas; incineration and other thermal processes." to be clearer on the energy from waste possibilities. (Jean Bogner, Landfills +, Inc)	Sent request to Andre for modificatino of text
4-1083	A	42	7	42	14	None of the general statements in this paragraph require any reference (Sims, 2003 and IEA Bionergy, 2005) (JUAN CARLOS ABANADES, INCAR-CSIC)	Accept partly. Added "e.g.,", to make clear there are other source.s
4-39	B	42	10	42	10	Add: Prior to conversion processes, biomass tends to have low-energy density..... (Government of Germany)	Accept
4-1084	A	42	13	0	0	Please change "will" to "can" where says "will be minimized if biomass . . ." U.S. Government (Government of U.S. Department of State)	Accept
4-1085	A	42	16	42	16	Reference to 46 EJ of bioenergy is meaningless and misleading. What is important, is how much energy is from "new" biomass. (Christopher Green, McGill University)	Reject, because still an important number (but say that mos is traditional, often inefficient)
4-1086	A	42	16	42	16	Reference to 46 EJ of bioenergy is meaningless and misleading. What is important, is how much energy is from "new" biomass. U.S. Government (Government of U.S. Department of State)	Same as 1085
4-1087	A	42	16	42	19	Is this referring only to "modern" energy? Is "traditional" biomass included or not? If not, traditional is 37 EJ, making the total share much higher than 10%. Is the 10% figure sited on line 18 consistent with Table 4.3.1? U.S. Government (Government of U.S. Department of State)	Traditional included, is now made clear. Comparison with 4.3.1 done.
4-1088	A	43	0	43	0	Fig. 4.3.7 is too complex to be useful (Government of France)	Reject, complexity not a reason to delete.
4-1089	A	43	1	43	1	Figure 4.3.7. sources?, same for Figure 4.3.10 (Government of European Community / European Commission)	Will provide
4-1090	A	43	1	43	0	This chart is unreadable as presented and should be deleted. The right hand column endpoints are not presented and could not be reviewed. U.S. Government (Government of U.S. Department of State)	Reject. Right endpoints will be made visible, and "sharpness" increased.
4-1091	A	43	1	43	0	Figure - Please insert the units in Figure 4.3.7 U.S. Government (Government of U.S. Department of State)	Accept

4-1092	A	43	2	0	0	Figure 4.3.7 need to be redraw. Its too small and sources are unknown. Not defining charcoal. What is traditional biomass? (NOIM UDDIN, Macquarie University, Sydney)	Accept
4-1093	A	43	2	0	0	After “flows” insert “(EJ/yr)” (Danny Harvey, University of Toronto)	Accepted
4-1094	A	43	5	0	10	This feels a very misleading calculation, since the efficiency of conventional biomass is so low, that replacing it with modern fossil fuels would not increase emissions by anything like 3.67GtCO2eq. (Chris Mottershead, BP)	Accept
4-1095	A	43	5	0	0	I'm not sure this calculation is worthwhile presenting. Given that most traditional biomass is very inefficiently used, and that this is the largest part of biomass consumption, the comparison you make is bound to be an overestimate and makes the contribution of biomass to keeping emissions low too high. The actual figure is probably half of what you have calculated, but we can't be sure. (Michael Taylor, International Energy Agency)	Accept
4-1096	A	43	11	43	11	I do not think that most of “old biomass” is “renewable” in the sense that renewability is understood in an alternative energy context. The discussion on p.47, lines 13ff would appear to support the point I am making. (Christopher Green, McGill University)	Could not find these terms in these lines. Comment not addressed.
4-1097	A	43	13	43	0	“35%” This is highly controversial and difficult to quantify. A range may be better. Some countries have 50%. U.S. Government (Government of U.S. Department of State)	Accept.
4-1098	A	43	14	43	19	Please delete, sentence starting with ".. The existence of …" it does not supply information (Government of European Community / European Commission)	Accept
4-1099	A	43	21	44	2	This paragraph starts with something well known that does not need a reference (traditional use of biomass is about burning wood for cooking and heating) but then, it refers to some authors suggesting "alternative cooking fuels that can be produced in the rural community" like dimethyl ether from coal, synthetic fuels or ethanol gel ¡¡¡. I come from a poor background and I cannot understand how the poor are going to change from burning wood to burning these exotic fuels produced locally ¡ . what time scale, what developing path are we considering here? where is the context for this paragraph? (JUAN CARLOS ABANADES, INCAR-CSIC)	Reject deletion of reference, accept the rest.

4-1100	A	44	7	0	0	Insert “residues” after “tertiary” (Danny Harvey, University of Toronto)	Accept
4-1101	A	44	9	44	12	"Current combustion of over 130 Mt of MSW annually". This is a good number for OECD only, but the 0.6 EJ/yr assumes a lower energy value for the MSW than we assume in Chapter 10. Can we coordinate for consistency using the same references and assumptions? Same for the landfill gas, indicated here as a "technical potential of around 3 EJ/yr". (Jean Bogner, Landfills +, Inc)	Sent e-mail to Andre to Check
4-1102	A	44	15	44	14	Figure 4.3.8.: Nice graph, but please explain figure better, it rather presents the competition among land use aspects. (Government of European Community / European Commission)	Accept
4-1103	A	44	28	45	1	The sentence starting with " combuston of biomass for heat and steam generation remains the state of the art" need to be expanded to include innovations under state of the art to include use of high pressure boilers based on the Condensing Extraction Steam Turbines (CEST) principle, and steam internal reciprocating engines for medium size electricity generation plants ranging between 200kW to 1500kW (Francis Yamba, University of Zambia)	Partly accept
4-1104	A	45	4	45	5	Because of the comments above, the diagram in figure 4.3.9 under combustion needs to be adjusted slightly to incude two branches under steam, one steam turbine which is already existing and the other steam internal reciprocating engines for electricity generation, which is being suggested (Francis Yamba, University of Zambia)	See with Andre whether can be accepted
4-1105	A	45	7	0	0	Figure 4.3.9 Ref? (TAR) (NOIM UDDIN, Macquarie University, Sydney)	Accept
4-1106	A	45	10	0	11	Biodiesel and methyl esters are not made from sugars. Plants that convert lignocellulose into sugars are also often called a biorefinery. (Wolter Elbersen, WUR, AFSG)	Accept
4-1107	A	45	10	45	15	bio-chemical technology can covert cellulose in to bio-diesel directly instead of convert into souger then to bio-diesel (Li Junfeng, Energy Research Institute of National Development and Reform Committee and Secretary General of China Renewable Energy Industry Association.)	Is this true?
4-1108	A	45	10	45	15	It's good that you revised the 1st draft to mention the potential to integrate	Asking Andre about changing Figure.

						biological and thermochemical processing within a single biorefinery. It would also be good to indicate that this integration is possible in Fig. 4.3.9 on pg 45, "Thermochemical and biochemical conversions from a range of biomass feedstocks..." Integration of biological and thermochemical processing greatly increases overall processing efficiencies, as much of the "waste heat" from thermochemical processing can be used as process energy for biological processing. The Role of Biomass in America's Energy Future project has modelled over a dozen scenarios in this vein with efficiencies between 70 and 80%. (RBAEF is currently preparing manuscripts to be published later this year in Biomass & Bioenergy.) Also, technically, synthesis gas from gasification can be fermented. BRI Energy is a company developing this technology. See www.brienergy.com. (Lee Lynd, Dartmouth College)	
4-1109	A	45	10	45	11	While there is the technical capability to convert cellulose into sugars that in turn can be converted to biofuels and biochemicals, the conversion is far from economic. See, for example, the U.S. Department of Energy's National Renewable Energy Laboratory's website: http://www1.eere.energy.gov/pdfs/36178c.pdf . Add" "However, this technology is not commercially competitive and a breakthrough in cellulose conversion technology is needed to make it competitive." at the end of line 11. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accept
4-1110	A	45	10	45	11	While there is the technical capability to convert cellulose into sugars that in turn can be converted to biofuels and biochemicals, the conversion is far from economic. See, for example, the U.S. Department of Energy's National Renewable Energy Laboratory's website: http://www1.eere.energy.gov/pdfs/36178c.pdf . Add" "However, this technology is not commercially competitive and a breakthrough in cellulose conversion technology is needed to make it competitive." at the end of line 11. U.S. Government (Government of U.S. Department of State)	See 1109
4-1111	A	45	17	45	20	"..using flex fuel engines in vehicles….for high content ethanol blends (e.g. E 30-85?)" U.S. Government (Government of U.S. Department of State)	
4-1112	A	46	3	0	0	Suggest cite "(Faaij, 2006)". (Peter Read, Massey University)	Reject (trivial statement)
4-1113	A	46	3	46	3	Suggest cite "(Faaij, 2006)". (Peter Read, Massey University)	See 4-1112

4-40	B	46	7	46	7	efficiency 40-50 %: clarify which kind of efficiency this is; typical gasification efficiencies are much higher, biomass-to-electricity efficiencies lower than this number. (Government of Germany)	Accept
4-1114	A	46	8	0	0	after "turbine." add "Such gasification provides a low cost route, through a shift reaction with H2O, to future separation of CO2 in a capture ready installation (see Section 4.3.6)". (Peter Read, Massey University)	Reject. IF this is a low cost route, then coal gasif would be even more low cost ro ute. BioCCS is mentioned in several other places.
4-1115	A	46	8	46	8	after "turbine." add "Such gasification provides a low cost route, through a shift reaction with H2O, to future separation of CO2 in a capture ready installation (see Section 4.3.6)". (Peter Read, Massey University)	See 1114
4-1116	A	46	21	46	24	The positive effect on rural development is a very strong driver of biofuels for transport in OECD countries. Ample evidence can be found of this in EU, USA and France. See Eu Biofuels directive, 2003. (Wolter Elbersen, WUR, AFSG)	Accept
4-1117	A	46	29	46	37	Mention the large growth in the EJ over the past years. (Government of European Community / European Commission)	Accept
4-1118	A	46	30	46	0	"…China–check if ethanol is used in transportation. Other reports are only for drinking. U.S. Government (Government of U.S. Department of State)	Reject – must trust literature
4-1119	A	46	37	0	0	should be "economically viable at the larger scale." (Michael Taylor, International Energy Agency)	accept
4-1120	A	46	39	46	45	Numbers quoted are not referenced (Christine Copley, World Coal Institute)	Accept
4-1121	A	46	39	46	45	The paragraph is important and provides figures on costs but will require references to back the figures provided (Francis Yamba, University of Zambia)	See 4-1120
4-1122	A	46	40	46	45	When discussing the cost potential of biomass fuels, you should note that the Role of Biomass in America's Energy Future project has projected that with mature technology, cellulosic biofuels produced with mature technology can be cost competitive with petroleum by 2015--a much shorter timeframe than the 2030 date indicated in the text. See NRDC's "Growing Energy" report as a reference: http://www.nrdc.org/air/energy/biofuels/contents.asp	FROM HERE ON NOT YET IMPLEMENTED IN CHAPTER Accept

						(Lee Lynd, Dartmouth College)	
4-1123	A	46	41	46	0	USD 0.60/lge (USA). This seems a bit high. Sources are recommended. It is thought to be around 0.48/lge for corn ethanol. Does this include amoritization of capital cost? U.S. Government (Government of U.S. Department of State)	Accept
4-1124	A	46	44	46	45	Check cost projections for all sources and geographies. U.S. Government (Government of U.S. Department of State)	Accept
4-1125	A	47	0	47	0	Fig; 4.3.10: How much would the figure change for higher oil prices ? (Government of France)	Can be extrapolated. No action.
4-1126	A	47	1	47	0	Figure - This is a very important graph. Suggest splitting this into 2 figures to make it more readable. Also, some explanation needs to be provided of what the vertical lines on the right represent, which should be competitive over a range of crude oil prices. Also, the x-axis ($/bbl) needs to be displayed. U.S. Government (Government of U.S. Department of State)	Ralph? Move to transportation?
4-1127	A	47	3	47	3	Figure 4.3.10, please mentioned sources and should this figure not be converted to Chapter 5? (Government of European Community / European Commission)	Ralph? Accept
4-1128	A	47	5	47	10	This paragraph equally requires references as above (Francis Yamba, University of Zambia)	Accept
4-1129	A	47	5	47	0	Sentence should be restated: Today, ES can compete…. By 2030, if cost estimates are reached, ES, ELC would both compete with oil prices around USD40/bbl and BA and BV would compete at around USD 60/bbl. U.S. Government (Government of U.S. Department of State)	Acccpet
4-1130	A	47	5	47	10	Provide references. Seems high regarding Brazil. Compare costs over past decades" U.S. Government (Government of U.S. Department of State)	Accept
4-1131	A	47	6	47	8	line 6 replace "will" with "currently". Line 8 before "Otherwise" insert "Ethanol from cellulose and electricity from lignin residues, co-produced with protein for cattle feed is projected to be competitive with oil at $35/bbl by 2025, given normal engineering progress (Greene et al, 2005). (Peter Read, Massey University)	Accept
4-1132	A	47	6	47	8	line 6 replace "will" with "currently". Line 8 before "Otherwise" insert "Ethanol from cellulose and electricity from lignin residues, co-produced with protein for cattle feed is projected to be competitive with oil at $35/bbl by 2025, given normal	See 1131

						engineering progress (Greene et al, 2005). (Peter Read, Massey University)	
4-1133	A	47	12	47	12	do not use bold (Stefano Caserini, Politecnico di Milano)	Yes, higher level section nmbering?
4-1134	A	47	18	0	0	What is CDM? Ref about CDM EB decision? How does it relates to this biomass potential? (NOIM UDDIN, Macquarie University, Sydney)	Ok
4-1135	A	47	22	47	24	"Carbon stocks in ecosystems . . . considered renewable." Is this true? Source would be helpful. U.S. Government (Government of U.S. Department of State)	Make conditional, accept
4-41	B	47	22	47	25	The authors should more clearly explain the principle that a bionergy can only be considered renewable if it results in emissions being sequestered, rather than emitted. (Government of Australia)	Accept
4-1136	A	47	23	0	0	after "renewable" insert "there" (Peter Read, Massey University)	Accept
4-1137	A	47	23	47	23	after "renewable" insert "there" (Peter Read, Massey University)	See 1136
4-1138	A	47	26	0	0	after "revegetation" add "or CCS" (Peter Read, Massey University)	Accetpt
4-1139	A	47	26	47	26	after "revegetation" add "or CCS" (Peter Read, Massey University)	See 1138
4-1140	A	48	1	48	10	Given the context, I think that the articles by Farrell, et al., Science (2006) v.311: 506-508, and Pimentel and Patzek, Natural Resource Research (2005) March: 65-76 should be cited. (Christopher Green, McGill University)	Ok, plus add otehrs from Francesco
4-1141	A	48	1	48	10	Given the context, it is thought that the articles by Farrell, et al., Science (2006) v.311: 506-508, and Pimentel and Patzek, Natural Resource Research (2005) March: 65-76 should be cited. U.S. Government (Government of U.S. Department of State)	See 1140
4-1142	A	48	5	48	6	Clarify "but for corn to ethanol in coal fired process plants in US". U.S. Government (Government of U.S. Department of State)	accept
4-1143	A	48	6	0	0	After "US" insert ", where the driver is energy security rather than climate policy"	Reject, out of context

						(Peter Read, Massey University)	
4-1144	A	48	6	48	6	After "US" insert ", where the driver is energy security rather than climate policy" (Peter Read, Massey University)	See 1143
4-1145	A	48	9	48	9	These numbers may need some backing up. They are potentially controversial from a policy perspective. (Government of Environment Canada)	Ok, francesco to help me
4-1146	A	48	9	48	0	"Check numbers" Add references. U.S. Government (Government of U.S. Department of State)	Accept (see also 1145)
4-42	B	48	9	48	9	Add: The overall energy balance not only depends on the process efficiencies themselves, but also on the degree and kind of co-product use. E. g. for biodiesel, the substitution of fossil glycerine production is one of the major determinants of the energy balance (Ifeu 2005). Ifeu 2005: CO2 mitigation through biofuels, Status and perspectives. Study commissioned by the Forschungsvereinigung Verbrennungskraftmaschinen. Institute for Energy and Environmental Research, Heidelberg. Download www.fvv.de (Government of Germany)	Accept
4-1147	A	48	11	48	37	The discussion that the different bioenergy systems have varying degrees of effectiveness in mitigating GHG emissions and that the mitigation depends on the fossil reference system is important. As is the statement that the GHG benefits per unit of land is the most appropriate measure when land resources are limited. We suggest that specific numbers are given for different bioenergy systems and different types of lands and land uses, and that the numbers are linked to different fossil reference systems. The mitigation potentials (regional and global) for some different mitigation strategies could then be shown e.g. focusing on the maximum GHG mitigation a) in an over-all perspective, b) for a specific sector (electricity, heat, transportation), c) for a specific sector and a specific land use (transportation and corn ethanol, etc.). This will help to better understand the greenhouse gas benefits of bioenergy for different mitigation strategies. (Government of Sweden)	Accept. Franceso to help
4-1148	A	48	13	48	24	Some biomass fuels are produced through use of high GHG fuels eg sugar fertilized with compunds from high GHG factories and irrigated with high GHG water and processed with a coal input (off season) may have a very poor GHG dispalcement potential. It is important to do a lifecyle assessment of biomass fuels. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Accept
4-1149	A	48	15	0	0	Change "any" to "the"	Accept

						(Danny Harvey, University of Toronto)	
4-1150	A	48	16	48	17	Clarify "transporting biomass … can be replaced." An example may help. U.S. Government (Government of U.S. Department of State)	Accept
4-1151	A	48	18	48	19	Delete the last phrase (it is not needed) (Danny Harvey, University of Toronto)	Need to think aboutu this
4-1152	A	48	20	48	20	I suppose this paragraph and following diagram in someone's pet baby, but I found it quite confusing. All that is really needed is the second sentence (stripped of references to the diagram). (Peter Read, Massey University)	At least shorten this
4-1153	A	48	20	48	20	I suppose this paragraph and following diagram in someone's pet baby, but I found it quite confusing. All that is really needed is the second sentence (stripped of references to the diagram). (Peter Read, Massey University)	See 1153
4-1154	A	48	21	48	25	Run-on sentence (Danny Harvey, University of Toronto)	Accept
4-1155	A	48	21	48	37	The text fails to make the implications of biomass resource scarcity for carbon balances explicit. For a detailed discussion and explicit examples on this aspect refer to Grönkvist S and Sjödin J (2004). Models for Assessing Net CO2 Emissions Applied on District Heating Technologies. International Journal of Energy Research 27(6): 601-613. (Kenneth Möllersten, Swedish Energy Agency)	Accept
4-1156	A	48	21	48	37	The whole of the explanation of Figure 4.3.11 is very hard going. Some thought should go into improving the explanation or removing the chart altogether. (Government of Environment Canada)	Accept
4-1157	A	48	24	48	37	This appears very confusing. It is recommended that this section be either condensed or deleted as it is not clear what point is being made. U.S. Government (Government of U.S. Department of State)	Accept
4-1158	A	48	25	0	0	Shouldn't "increased" be "decreased"? (Danny Harvey, University of Toronto)	Accept
4-43	B	48	25	48	25	"will be increased" means: will be improved, i. e. the factor will be lowered (Government of Germany)	Accept
4-1159	A	48	29	0	0	Should read " and thus low GHG per" (Danny Harvey, University of Toronto)	Yccept

4-1160	A	48	31	0	33	The ratio discussed must indicate the efficiency with which the GHG balance is improved and not the efficiency with which energy is delivered. (Government of Sweden)	Need to think about htis.
4-1161	A	48	32	0	0	Delete “and hence where land resources are not limited”. Next sentence should begin as: “A low GHG/GHGref …” (Danny Harvey, University of Toronto)	Accept
4-1162	A	48	35	0	0	I think that you mean land use efficiency, not biomass use efficiency. The last part of the sentence (no net GHG benefit) is a mystery to me. (Danny Harvey, University of Toronto)	Need to check
4-1163	A	48	37	48	37	Add a specific discussion of the fossil fuel consumption throughout the life cycle from soil to wheel. (Government of France)	Accept
4-1164	A	49	1	49	0	Figure - There are no numbers here. What is the relevance of this figure? U.S. Government (Government of U.S. Department of State)	Will delete Figure
4-1165	A	49	3	49	3	Figure 4.3.11. what do the arrows mean in this figure (Government of European Community / European Commission)	Will delete figure
4-1166	A	49	4	50	3	This section could provide more details on the environmental impacts of bio-energy production and how careful selection of crops / agricultural practices can minimize adverse effects. See for instance the recent (2006) European Environment Agency study "How much bioenergy can Europe produce without harming the environment?", which can be found at http://reports.eea.europa.eu/eea_report_2006_7/en/eea_report_7_2006.pdf. This report also contains extensive references on this subject. (Peter Taylor, International Energy Agency)	Accept
4-1167	A	49	4	49	4	Should there be some discussion about biomass (particularly from animal waste) providing a cheap and clean source of cooking fuel for farming villages? I'm seeing more of this in China where small villages (even in coal producing areas) are improving their lives through using small amounts of animal waste for cooking and running lamps in there homes (this is done at the household level). In the short term, this goes a long way to improving their health and the environment. (Katherine Casey Delhotal, Research Trinagle Institute)	Accept
4-1168	A	49	5	24	49	These paragrahs need references (John Kessels, Energy Research Centre of the Netherlands)	Accept

4-1169	A	49	5	25	0	"Non irrigated levels offer enhanced GHG reduction due to lower energy use per hectare via avoidance of pumping (and are more sustainable re water table reductions)" U.S. Government (Government of U.S. Department of State)	Reject. Incorrect and too detailed.
4-1170	A	49	9	0	0	After "Asia" insert " This diversity of potential suppliers ensures a broadly competitive market (maybe initiated through a series of bilateral bioenergy partnerships as suggested in Chapter 13) so that growing world trade in liquid biofuels does not present the same energy security risks as does current dependence on traded oil supplied mainly by OPEC countries, which have, in the 1970's, demonstrated willingness to act oligopolistically." (Peter Read, Massey University)	Reject?
4-1171	A	49	9	49	9	After "Asia" insert " This diversity of potential suppliers ensures a broadly competitive market (maybe initiated through a series of bilateral bioenergy partnerships as suggested in Chapter 13) so that growing world trade in liquid biofuels does not present the same energy security risks as does current dependence on traded oil supplied mainly by OPEC countries, which have, in the 1970's, demonstrated willingness to act oligopolistically." (Peter Read, Massey University)	See 1170
4-1172	A	49	11	49	0	Insert the following at the beginning of the sentence that starts with "Improved:" "Sustainable biomass cultivation can result in" and remove "can result" after "degrade soils" U.S. Government (Government of U.S. Department of State)	Accept
4-1173	A	49	16	49	24	Please be more concrete, do you have references and numbers to underpin this statement? (Government of European Community / European Commission)	Accept, insert refs
4-1174	A	49	16	49	0	Replace "uptake" with "use" U.S. Government (Government of U.S. Department of State)	Accept
4-1175	A	49	17	49	17	There is no section 4.7.4 in the chapter?? (John Kessels, Energy Research Centre of the Netherlands)	Need to check
4-1176	A	49	17	0	0	Reference should be to section 4.5.4 (Peter Read, Massey University)	Sneed to check
4-1177	A	49	17	49	17	Reference should be to section 4.5.4 (Peter Read, Massey University)	See 1176
4-1178	A	49	17	0	0	The reference to section 4.7.4 is inadequate, there is no such numbered section in	Same

						the chapter. (Government of Sweden)	
4-1179	A	49	18	0	19	Suggested amendmen concering "raw material supply": delete “raw”, add italics:...other biomass related policies, primary and secondary wood materials for industry.... (See Chp 9, section 9.4.6.1 “Type of forest residues” page 37, lines 11-13 for explanations). (Government of Sweden)	ACCEPT
4-1180	A	49	20	49	20	Quantify this statement, eg compare the surface required to produce 10 % of the world oil consumption with the global surface used by agriculture. How much water and intrants would be required ? (Government of France)	ACCEPT
4-1181	A	49	20	49	0	It would be useful to provide a fuller discussion of the alleged conflicts with food production, including the economic impacts of biofuel production on food and livestock feed prices, especially in the developing world. U.S. Government (Government of U.S. Department of State)	Refer to ag chapter (Pete)
4-44	B	49	20	49	20	add: food production, biodiversity and extensification of the agricultural system (Government of Germany)	Accept
4-1182	A	49	26	48	26	Biofuels being "dirty" is not always just a perception. In some cases (peat burning, e.g.), it's also reality. (Government of Environment Canada)	Accept
4-1183	A	50	3	50	0	Replace “consents” with “permits” U.S. Government (Government of U.S. Department of State)	Accept
4-1184	A	50	5	50	30	There are two very important issues that should be discussed here. (1) Overall, biomass energy is a very inefficient way of converting solar energy into useful energy for people. This is because the basic efficiency of photosynthesis is around 1-2%, and there are further losses in converting biomass energy to other forms. This point needs to be clearly made; otherwise, some readers might have unrealistic expectations about the role of biomass. Biomass, as I see it, is good when it is largely residues that would otherwise be wasted that are being used. (2) Not all uses of biomass are equally sensible from the point of view of building a sustainable energy system. Using biomass as transportation fuel in private automobiles in particular is a rather poor use of biomass, given the inherent inefficiency of any form of transportation system based on personal automobiles (compared to rail based mass transit in compact urban centers) and the much greater efficiency in using biomass for combined heat and power. Biomass is even more interesting as a	See response from CCT group (too detailed), but some good points.

						natural complement and backup to solar energy for space and water heating. Thus, we really need to look at the much larger system. These considerations imply that we really need to put much more emphasis on appropriate urban form than at present in most parts of the world, so this has implications for Chapter 5, and there should be some integration and systems thinking between the two chapters. Also, economic or political forces (as in the US and Canada at the moment, if not elsewhere) may force uses of biomass that are in fact suboptimal, so clear government intervention may be needed to make sure that the limited biomass energy potential is used in the most effective way, with the greatest possible impact in terms of GHG emission reduction. Section 4.3.3.3 as written now is just a compendium of different ways of using biomass, without these broader considerations and perspectives, which are important considerations. (Danny Harvey, University of Toronto)	
4-1185	A	50	5	50	14	A report by Common Fund For Commodities shows potential of sugar cogen in East Africa. May ask Common Fund for Commodities in Amsterdam. Also AFREPREN in Nairobi has information on Africa biomass market. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Reject – too detailed.
4-1186	A	50	5	50	30	Under the future bioenergy potential, use of solar to fuels, artificial photosynthesis using synthetic biological process may be included. Solar photo catalytic(nano) cells for hydrogen and other fuel generation will be an important step in future bio energy conversions. Under 4.3.3.3 this may be included. (Government of India)	Accept
4-1187	A	50	6	50	14	Please define the type of potential that has been considered; technical, economic, socio-economic potential? (Government of European Community / European Commission)	Accept
4-1188	A	50	6	50	14	The bioenergy potentials given in the text and based on Hoogvijk (2004) should be reconsidered. The study has assumed that very large areas for energy plantations will be available and that all of the energy grown is directly available, with a conversion efficiency of that of biomass integrated gas combined cycle or F-T synthesis. The conversion losses of the whole energy system are ignored. Also the questions related to integration with the rest of the energy system are ignored. With high amounts of bioenergy use, the required transportation costs (and related emissions) will become substantial. On the other hand, with small-scale technologies the conversion efficiencies will decrease substantially. Also the availability of water for plantations has been ignored. The study has largely	See conclusions CCT bioenergy

						concentrated on short-rotation energy plantations, which may also not be a fully valid assumption. Based on this study (with clear weaknesses), bioenergy potential estimates have been also derived to the SPM, page 14. (Government of Finland)	
4-1189	A	50	13	0	0	What is the meaning of "research focus supply side potential" ? (JUAN CARLOS ABANADES, INCAR-CSIC)	Theoretical potential?
4-1190	A	50	13	0	0	After "220 EJ" Insert "Read and Parshotam (2006, under review) estimate 392 EJ in 2035 and 569 EJ in 2060 under an ambitious land use improvement programme funded by energy firms (driven by rapidly increasing biofuel obligations implementing policy concerns over potential abrupt climate change) to invest in raising sustainable land productivity to co-produce food or fibre with biomass energy raw material ('tilling not drilling, cultivating not excavating')." (Peter Read, Massey University)	Reject, not accepted for pub
4-1191	A	50	13	50	13	After "220 EJ" Insert "Read and Parshotam (2006, under review) estimate 392 EJ in 2035 and 569 EJ in 2060 under an ambitious land use improvement programme funded by energy firms (driven by rapidly increasing biofuel obligations implementing policy concerns over potential abrupt climate change) to invest in raising sustainable land productivity to co-produce food or fibre with biomass energy raw material ('tilling not drilling, cultivating not excavating')." (Peter Read, Massey University)	See 1190
4-1192	A	50	17	50	18	Please indicate the contribution of the subisidy, if any, to the figure of USD 2/GJ (JUAN CARLOS ABANADES, INCAR-CSIC)	Ask monique
4-1193	A	50	20	50	21	Refer to Goran Berndes paper on irrigation requirements for bioenergy (Government of European Community / European Commission)	Ask Goran for paper
4-1194	A	50	22	50	26	Generation costs of 10-12 cents/kWh for a plant with capital costs of $2000/kw falling to $1,100/kW sound way too high. Also, I don't see where these costs are reported in Martinot 2005. For example, Table 2 on pg. 12 of the report shows biomass electricity costs of 5-12 c/kWh. Table N11b on page 19 of the appendix of the report shows biomass electricity of 5-15 c/kWh (current) and 4-10 c/kWh (projected in future). The US Energy Information Administration projects costs of 5.5 c/kWh for a plant built in 2012 in its Annual Energy Outlook 2006 report. The Electric Power Research Institute projects costs to fall from ~6.2 c/kWh in 2010 to ~4.4 c/kWh in 2020 (Specker, Steve. Generation Technologies in a Carbon-constrained World. Electric Power Research Institute. PowerPoint presentation. Mar. 2006.)	Comment for Erik

						(Steve Clemmer, Union of Concerned Scientists)	
4-1195	A	50	22	50	26	Generation costs of 10-12 cents/kWh for a plant with capital costs of $2000/kw falling to $1,100/kW sound way too high. Also, I don't see where these costs are reported in Martinot 2005. For example, Table 2 on pg. 12 of the report shows biomass electricity costs of 5-12 c/kWh. Table N11b on page 19 of the appendix of the report shows biomass electricity of 5-15 c/kWh (current) and 4-10 c/kWh (projected in future). The US Energy Information Administration projects costs of 5.5 c/kWh for a plant built in 2012 in its Annual Energy Outlook 2006 report. The Electric Power Research Institute projects costs to fall from ~6.2 c/kWh in 2010 to ~4.4 c/kWh in 2020 (Specker, Steve. Generation Technologies in a Carbon-constrained World. Electric Power Research Institute. PowerPoint presentation. Mar. 2006.) (Steve Clemmer, Union of Concerned Scientists)	See 1194

Comments on section 4.3.4 – 4.3.8 (Bob + Clive)

4-1245	A	56	21	62	46	The discussion on 'Energy Carrier' looks supplementary. It is suggested that the discussion on electricity, heat, liquid and solid fuels may be deleted as these carrier have already been discussed in Sections 4.3.1, 4.3.2 and 4.3.3. However discussion on 'Hydrogen' may remains under the heading of 'Innovative Energy Carrier'. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	Noted
4-1246	A	56	25	0	0	You should talk about the continued growth in the importance of electricity, not just about shift from solids to liquids and then to gas. (Michael Taylor, International Energy Agency)	accept
4-61	B	56	26	50	2	Transportation sector natural gas use has grown very slowly. This is true except for the transportation sector. Also, should reference to figure be 4.3.14 instead of 4.3.12? U.S. Government (except for the second sentence, "This is true . . .") (Government of U.S. Department of State)	accepted
4-1247	A	57	1	57	12	Please explain what scenarios A, B, and C are. Are these climate mitigation scenarios such as stabilization at 450, 550, etc. If so that is an important point to share with th readers. The Integrated Assessment literature has demonstrated that in the presence of a binding greenhouse gas constraint the world accelerates the already evident trend of greater reliance on electrification. If that is the point that the authors are trying to make, that climate change mitigation accelerates the transition away from point of use combustion of carbenaceous fuels and towards non emitting energy carriers like electricity and H2 then please come out and say it	Noted – get update from Naki

						more clearly. Also what is meant by "Solids (biomass)" here? Is that traditional forms of biomass such as dung and scaviging for wood for cooking? Most models would suggest that bioenergy would grow through out this century and that while some of it would go to making biofuels a significant fraction would be used for power generation and industrial uses. I am surprised to see biomass decline that fast by the end of the century. Did the modeling that underpins this chart assume that biomass would only be used for transport fuels? If so that needs to be noted as I do not think there is any universall agreement in the literature on that point. (James Dooley, Battelle)	
4-1248	A	57	2	57	4	The figure does not show off-grid heat, giving no existence to solar heat. At a minimum the caption should indicate this as a caveat. (Cédric PHILIBERT, International Energy Agency)	Accept – at least the caveat
4-1249	A	57	7	0	0	In a strong GHG mitigation scenario you would see grid energy carriers approaching 50% of consumer energy much sooner, perhaps by 2050. See IEA Energy Technology Perspectives 2006. (Michael Taylor, International Energy Agency)	Noted – find new figure ETP or IIASA
4-1250	A	58	1	58	6	Fig 4.3.15 is too complicated for me. It carries too much information which is better put in a text format. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Noted
4-62	B	58	1	58	0	Figure 4.3.15. Why not show option of coal/peat to syngas? U.S. Government (Government of U.S. Department of State)	Noted – change natural gas to methane
4-63	B	58	2	58	2	Fig 4.3.15 is not very helpful (Government of Germany)	
4-1251	A	58	16	0	0	each energy conversion step can, but does not necessarily have to result in CO2 emissions (ie renewable energy-based electricity networks). (Michael Taylor, International Energy Agency)	Noted – add potential emissions
4-1252	A	59	1	59	3	Table 4.3.3 should list LPG under natural gas derived fuels not under oil derived fuels. Earlier in the chapter, Pg. 27, lines 9-13, LPG is correctly listed under naturla gas derived fuels. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accept – but check consistency
4-64	B	59	1	59	0	Table 4.3.3 "Under Biomass Slurry—in R&D/pilot phase (e.g., Shell Htu process.)" U.S. Government (Government of U.S. Department of State)	Noted – no proper reference
4-1253	A	59	7	0	0	You should add that electricity is the highest value energy carrier because it can be	Accept

						used in so many high-value end-uses that greatly enhance productivity at a personal and economic level. (Michael Taylor, International Energy Agency)	
4-1254	A	59	9	59	9	Another example of unnecessary reference (EPRI, 2003) for the sentence "Generating electricity involves converting a primary energy source". My school teacher told me the same many years ago. In this case, the reference can appear later. (JUAN CARLOS ABANADES, INCAR-CSIC)	Noted
4-1255	A	59	10	59	14	Instead of only referring to the USA regarding electricity intensity, the IEA owns interesting historical world data and forecasts world electricity intensities up to 2030. These numbers are shown in Verbruggen A. "Electricity intensity backstop level to meet sustainable backstop supply technologies", Energy Policy 34(2006), pp.1310-1317. They are ~320 kWh/1000US$-95 PPP world GDP on average for the period 1971-2001, and would fall to ~210 kWh on average for the period 2001-2030 (IEA 2003: World Energy Investment Outlook). When the latter average is reached along a smooth logarithmic pattern the intensity would be ~190 kWh. This is at odds with the last sentence on lines 12-14 that assumes a constant intensity. (Aviel VERBRUGGEN, University of Antwerp)	Accepted – put in the text
4-1256	A	59	10	59	12	Point is taken well but for the international report of this kind wouldn't it be better to assess based on cross-country comparison rather than picking convenient US statistic. (Government of India)	See 4-1255
4-65	B	59	10	59	12	"Although global energy intensity (E/GDP) continues to decrease, the percentage of primary energy used to generate electricity has steadily increased as exemplified by the US (Figure 4.3.16) such that the ratio of electricity produced to GDP has remained constant." The logic expressed in this sentence is poor. The percentage of primary energy used in electricity is a consequence of electricity's increasing market share of end-use energy, and does not have any direct relationship to the electricity-to-GDP ratio. Revise this to read: "Electricity is growing as a share of energy end-uses, faster than other direct combustion uses of fuels; as a result, the electricity-to-GDP ratio has remained relatively constant even though the overall global energy intensity (E/GDP) continues to decrease." U.S. Government (Government of U.S. Department of State)	accept
4-1257	A	59	13	59	15	Can you relate that to chapter 3? (Government of European Community / European Commission)	noted

4-66	B	59	14	59	0	"...add, "…unless new efforts are made to increase energy efficiency on electricity demand sectors. U.S. Government (Government of U.S. Department of State)	accept
4-1258	A	60	10	60	13	Please split it up per resources. (Government of European Community / European Commission)	Reject – not relevant
4-67	B	60	10	60	12	It should be made clear that the increase in average efficiency from 1990-2002 for newer electricity generation plants is much more significant than 6%, as the average figures also include older less efficient plants that would have been incorporated into the 1990 average calculation as well as the 2002 average. (Government of Australia)	Reject – not on the point
4-1259	A	60	12	0	0	need to say "reducing GHG emissions below what they otherwiswe would have been." (Michael Taylor, International Energy Agency)	accept
4-1260	A	61	0	61	0	figure 4.3.17: spell out the abbreviations CC, SCR, IGCC in the legend of the figure itself (Aviel VERBRUGGEN, University of Antwerp)	accept
4-1261	A	61	1	61	10	The official IPCC term for CCS is "carbon dioxide capture and storage" it is not "carbon capture and storage" and it is not "CO2 sequestration" as stated in Figure 4.3.17. Please do a global search and replace and stick with "CO2 capture and storage" or "carbon dioxide capture and storage." (James Dooley, Battelle)	accept
4-1262	A	61	1	61	4	the abreviation "SCR" is not defined; what does it mean? in power sector, SCR is "selective catalytic reduction" that means an important secondary measure to reduce Nox-emissions; however, we do not see any context to the issue in Figure 4.3.17; please clarify! (,)	Reject – no reference
4-1263	A	61	5	61	14	Chapter 4.3.4.1 misses a clear concept. Nuclear is always listed in line with renewable energy sources. This should be corrected, as nuclear is a current conventional source and not an advanced technology of the future. In lines 7 and 8, nuclear should be deleted and geothermal power plants should be added. (Sven Teske, Greenpeace International)	Nored – include geothermal
4-1264	A	61	5	61	15	This paragraph contains some wrong statemetns and need rewriting. The advanced technologies referred, may contribute to mitigate CO2 emmisiones, but they do not "increase the overall efficiency of energy use". In fact, they reduce it (at least for	Reject – no refernces

						CCS, and for renewables with low energy efficiency). Also, I do not see in section 4.4 that "nuclear and CCGT with CCS may become the dominant technologies early this century" unless you understand with "early" something beyond 2050. Solar PV and hydrogen come later, but "will probably begin to penetrate the market earlier" ?. Is this a wish (that I would share) or a rigurous scenario building ?. (JUAN CARLOS ABANADES, INCAR-CSIC)	
4-68	B	61	10	61	10	The older IPCC view (2001) that CCS may become dominant early this century should not be repeated because newer IPCC estimations (IPCCSR) contradict this statement. Make clear that CCS is only possible and relevant as a bridging or backstop technology for a transitional period. (Government of Germany)	Noted – rewrite
4-1265	A	61	11	0	0	Line 11 suggests that solar PV and fuel cells are both electricity sources, but this is incorrect. Solar PV generates electricity from sunlight, while fuel cells are combustion engines. Fuel cells run on fossil fuels or may be fuelled with hydrogen in the future, which may come from renewables or from fossil fuels. (Sven Teske, Greenpeace International)	Reject – technically incorrect
4-1266	A	61	11	61	14	"Comment. I suggest to integrate the phrase: - Solar PV and hydrogen fuel cells may eventually become commercially viable and even dominate, but because of their current costs, complexity, and state of development, they may only do so later this century, even though they will probably begin to penetrate the market earlier.- in this way: Solar PV and hydrogen fuel cells may eventually become commercially viable and even dominate, but because of their current costs, complexity, and state of development, they may only do so later this century, even though they will probably begin to penetrate the market earlier as suggested in the book Prospect for hydrogen and fuel cell (2005 IEA). References: IEA, 2005, Prospects for Hydrogen and Fuel Cell, International Energy Agency, IEA/OECD, Paris. www.iea.org" (Mario Valentino Romeri, none – private Italian citizen)	Noted – incorporate reference
4-69	B	61	11	61	0	Hydrogen-fueled reciprocating internal combustion engines are a near-term, cost-effective conversion technology that cannot be neglected. Ford and BMW both have aggressive development programs to produce a market ready product. The current versions exhibit brake efficiencies near 40% with emissions (including Nox) at near zero values. Both companies have stated publicly that they anticipate efficiency near 50% in the future. These are production hardware designs, so cost	Accept – add sentence

						of manufacturing is only slightly higher than current gasoline ICE's ~$40/Kw. See SAE (2003-2004 Ford and BMW), National Hydrogen Association annual meetings 2004-2006. U.S. Government (Government of U.S. Department of State)	
4-70	B	61	12	61	12	This view seems biased. There are a number of studies contradicting a dominating role of PV and fuel cells. Why are these technologies highlighted so much in this paragraph? (Government of Germany)	Reject – no reference
4-1267	A	61	22	61	22	Section 4.3.6 is on carbon capture and storage not cogeneration (John Kessels, Energy Research Centre of the Netherlands)	Accept – shoulb be 4.3.5
4-1268	A	61	22	61	22	"…….process (section 4.3.5)….at times…". It should be section 4.3.5 and not section 4.3.6 (Government of India)	See 4-1267
4-71	B	62	1	62	1	Given the enormous importance of district heat, this one sentence here seems not sufficient. (Government of Germany)	noted
4-1269	A	62	6	62	13	Geothermal heating from shallow resources (vertical or horizontal heat exchangers in soils; wells producing from local aquifers…) offer interesting solutions for housing heating with heat pumps. Already 70% of new housing are heated with that process in Sweeden, and ratios of 50% are reached in Germany and Switzerland. There is a huge potential for growth of such systems in Europe (e.g. 50% of the market of new houses i.e. 150.000 housing/year in France) (VARET jacques, French Geological Survey)	Noted – for ch6
4-1270	A	62	12	0	0	Co-firing of biomass in coal power plants is neither the best use of biomass nor the most effective way of converting biomass into energy (electricity and heat). (Sven Teske, Greenpeace International)	Reject – no references
4-1271	A	62	24	0	0	This statement is quite strong, but there is no reference. For the residential sector it is oil and gas that dominate, with some exceptions in most cold climate countries. It would be good if you could add a reference for this wider statement. (Michael Taylor, International Energy Agency)	Noted – find reference
4-1272	A	62	29	62	34	"Yamashita and Barreto (2005), for instance, have examined the role that integrated energy systems, also known as 'energyplexes', could play in supplying energy demands in the long term. These systems could enable a multi-fuel, multi-product strategy with both economic and environmental benefits. They could increase the	Noted – add a sentence

						adaptability and robustness of energy-services companies in the marketplace, providing them with flexibility in meeting demands in different market segments while achieving lower production costs and, reducing the risks of reliance on a single feedstock. In addition, with the possibility of achieving high conversion efficiencies and low polluting emissions and facilitating carbon capture, they could deliver high-quality energy services in a cost-effective way while meeting stringent environmental requirements. In their study, the potential of energyplexes is highlighted here using the case of coal-fired, synthesis-gas-based gasification systems that allow co-producing hydrogen, electricity and liquid fuels, i.e. Fischer–Tropsch liquids and methanol, and could be a key building block in a clean-coal technology strategy. Co-production, also known as poly-generation, strategies may contribute to improve the economics of the system and exploit potential synergies between the constituent processes." References: 1. Yamashita, K., and L. Barreto, 2005: Energyplexes for the 21st Century: Coal gasification for co-producing Hydrogen, Electricity and Fuels. Energy 39, 2453-2473 (Leonardo Barreto, Paul Scherrer Institute)	
4-72	B	62	31	62	0	"…add butanol…" . Add "possibly butanol" U.S. Government (Government of U.S. Department of State)	Reject – no reference
4-1273	A	62	35	0	0	Section 4.3.4.3.Hydrogen. It is surprising that there is no mention of nuclear power in this section, for the production of hydrogen. It could be used for the essentially carbon free production of hydrogen, either by electrolysis of using high temperature reactors. There is a proposal by the US DOE to construct a prototype high temperature plant for hydrogen production at the Idaho site. There is considerable interest in this possibility elsewhere as well. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Noted – seee 4-74
4-1274	A	62	35	62	46	This section dicusses the potential hydrogen economy. It discusses the use of renewables or fossil fuels with CCS as potential sources of energy for hydrogen production, but does not mention the potential contribution of nuclear energy. The production of hydrogen from current nuclear plant designs through electrolysis or by using process heat from Generation IV reactors should be mentioned. Hydrogen production from process heat is an objective of the Generation IV programme. http://gen-iv.ne.doe.gov/GENIVPriorities.asp (Jonathan Cobb, World Nuclear Association)	Noted – seee 4-74
4-1275	A	62	37	62	46	Local efforts to develop non-conventional and renewable energy solutions, using hydrogen as energy storage, have been prooved to be competitive strategy to	Accept – add H energy storage

						replace conventional fossil fuel based ones, in general supported by subsides. The cooperation between international and local programs may be decisive for the progress of the stab;ishment of market niches of a hydrogen economy. (Demóstenes Barbosa da Silva, AES Brazil)	
4-1276	A	62	37	0	0	The hydrogen economy will also depend on the availability of competively priced fuel cells for mobile and stationary applications. (Michael Taylor, International Energy Agency)	accept
4-73	B	62	37	62	0	"A hydrogen economy depends…why start here? vs." Realizing hydrogen as an energy carrier…" U.S. Government (Government of U.S. Department of State)	accept
4-74	B	62	39	62	39	Add after "but electrolysis" "or high temperature splitting". Add "thermo-chemical water splitting" U.S. Government (Government of U.S. Department of State)	accept
4-1277	A	62	40	0	0	In addition to electricity and gas prices, the quality of hydrogen required for the fuel cells could encourage electrolysers if impurities in the hydrogen have to be minimised. (see IEA 2005, Prospects for Hydrogen and Fuel Cells). (Michael Taylor, International Energy Agency)	accept
4-1278	A	63	0	63	0	§4.3.5 on CHP. There are few references and some are not in the peer-reviewed literature. A link beteen CHP and CO2 emissions is made in Verbruggen A., Wiggin M., Dufait N., Martens A. "The Impact of CHP generation on CO2 emissions", Energy Policy 21 (1993) 408-417. Some comprehensive view on CHP is provided in Verbruggen A. "An introduction to CHP issues", Int. J. of Global Energy Issues 8 (1996) 301-318. More and recent references on detailed aspects can be supplied, but may be too specialised. (Aviel VERBRUGGEN, University of Antwerp)	Accept – include refernece material
4-75	B	63	5	65	11	Compared to CCS, cogeneration receives too little attention. Here, the CO2 mitigation potential could be quoted from different studies; the different cogeneration apllications (industrial, household, district heating,...) should be described. Given today's importance and the market maturity of cogeneration technologies, it should get more space than CCS. (Government of Germany)	noted
4-1279	A	63	6	63	7	Change "Up to two-thirds of the primary energy used to generate electricity..." to "Up to about a half of the primary energy used ot generate electricity...". <Rationale> Thermal efficiency varies from each plant to plant and the constituent ratio of those	Reject – incorrect

						plants varies from country to country. For example, thermal efficiency of the state-of-the-art Combined Cycle Gas Turbine power plants count nearly 50% (HHV) in Japan. These new power plants have been started their operation. (http://www.japannuclear.com/files/annualreport.pdf, p.10.) Hence, "up to about a half" should be more appropriate description considering recent rapid technology progress. (Shigeo Murayama, The Federation of Electric Power Companies)	
4-1280	A	63	7	63	17	Well illustrates the characteristics of CHP. CHP will play an significant role in power supply not only in the developed countries where large scale power plants with hierarchal power grid already in place but also helps those developing countries where power is not available at present time. CHP can provide necessary power and heat to improve the living in developing countries with least impact to the environment. (Satoshi Yoshida, The Japan Gas Association)	Accept – modify sentence
4-1281	A	63	7	63	17	Well illustrates the characteristics of CHP. CHP will play an significant role in power supply not only in the developing countries where large scale power plants with hierarchal power grid already in place but also helps those developing countries where power is not available at present time. CHP can provide necessary power and heat to improve the living in developing countries with least impact to the environment. (Government of Japan)	See 4-1280
4-1282	A	63	12	63	13	It is doubtful that the current designs can actually realise overall energy conversion efficiency of 80%. Because the pattern of the heat demand during year is different according to the country and the region, Table 4.3.4 should mention actual (realised) efficiency levels in addition to the designed levels. (Koji Kadono, Global Industrial and Social Progress Research Institute(GISPRI))	Noted – but no reference
4-1283	A	63	15	63	16	Delete the whole sentence of "About 75% of district heat in Finland for expmple is provided from cogeneration plants with a typical overall annual efficiency of 85-90%." <Rationale> There are no grounds in calculating the efficiency articulated in the reference book. Furthermore, refering these numbers should be misleading since there are no description whether this 85-90% is HHV or LHV in the source document. (Shigeo Murayama, The Federation of Electric Power Companies)	Noted – add in Finland, with low average temperatures,
4-1284	A	64	1	0	0	Table 4.3.4. – second line for steam turbines: the given electric efficiency for "any	Noted – must find reference for the table 4.3.4

						combustible" should have 47% (i.e. the current BAT level for coal) as maximum instead of 35%. This efficiency is for instance applicable to coal fired CHPs in Denmark. (Walter Ruijgrok, EnergieNed)	
4-1285	A	64	1	64	2	What is the source of Table 4.3.4 (John Kessels, Energy Research Centre of the Netherlands)	See 4-1284
4-1286	A	64	1	64	10	Table 4.3.4: it should be noted, that – due to thermodynamics - the maximum values of the electrical efficiencies can not be met I with the maximum values of the overall efficiencies! (,)	Noted – add note
4-1287	A	64	2	64	2	Commercialized CHP range from 1kWe (both gas engine & fuel cell). Government of Japan, both in federal and local subsidize the purchase of CHP for residential use. http://www.gas.or.jp/gasfacts_e/p_06/index.html, http://www.tokyo-gas.co.jp/pefc_e/dev-fc_21.html, http://www.g-life.jp/html/scene/cogeneration/ecowill/point/point09.html, http://www.pref.mie.jp/shigen/hp/energy/sien/hne.htm, http://www.gas.or.jp/default.html (in Japanese) (Satoshi Yoshida, The Japan Gas Association)	Accept – change line 3 in the figure
4-1288	A	64	2	64	10	In my book (Harvey, 2006a, Chapter 4) and in a recent paper (Harvey, 2006b), I have introduced the concept of the "marginal efficiency of electricity generation", which is defined as the electrical energy produced in a cogeneration plant divided by the extra fuel energy used in cogeneration compared to heating alone (producing the same amount of useful heat). Cogeneration is attractive from a total primary energy point of view if the marginal efficiency of electricity generation is greater than the generation efficiency times transmission efficiency of the central power plant that the cogenerated electricity displaces. The marginal efficiency depends in part on the efficiency of the boiler that would otherwise be used to produce heat. For high efficiency boilers (92-96%) in particular, and for microturbines (having a rather low overall efficiency, 60-70% or so, not 60-85% as given in Table 4.3.4), the marginal efficiency of electricity generation is LESS than that of state-of-the-art combined cycle power plants (up to 60% efficiency). Thus, small scale cogeneration is generally counterproductive from a climate point of view. This is an important point to make, as there is a lot of unjustified hype about microturbines at the moment. The full details of my arguments are succinctly presented in Harvey (2006b), which is included as an attachment.	Noted

						REFERENCES: Harvey, L.D.D. 2006a. A Handbook on Low-Energy Buildings and District Energy Systems: Fundamentals, Techniques, and Examples. James & James, London, 701 pages. Harvey, L.D.D. 2006b. Clean building: Contribution from cogeneration, trigeneration and district energy. Cogeneration and On-Site Power Production, September-October 2006, pp107-115. (Danny Harvey, University of Toronto)	
4-1289	A	64	2	0	0	The minimum output of commercialized CHP is 1kWe (both gas engine & fuel cell). Government of Japan, both in federal and local subsidize the purchase of CHP for residential use. <reference> http://www.gas.or.jp/gasfacts_e/p_06/index.html http://www.tokyo-gas.co.jp/pefc_e/dev-fc_21.html http://www.g-life.jp/html/scene/cogeneration/ecowill/point/point09.html http://www.pref.mie.jp/shigen/hp/energy/sien/hne.htm http://www.gas.or.jp/default.html (Government of Japan)	Accept – change figure 4.3.4, line 2
4-1290	A	64	10	0	0	Figure 4.3.19 is of very bad quality. Not only the grafics, but its redundant content. I suggest you delete it because you have already the nice figure 4.3.17 and table 4.3.4. (JUAN CARLOS ABANADES, INCAR-CSIC)	Accept – tidy the figure
4-1291	A	64	10	64	10	Add below sentence at the bottom of this paragraph (line 10) to illustrate concrete example of possibility for home and busiess CO2 reduction through heat pump use. Also add below bar charts. Air conditioning and hot water supply make up more than 50% of energy consumption in Japan by the civilian sector – homes and businesses. A complete switch from traditional fuel combustion to highly efficient heat pump use for those would allow a CO2 reduction of approx. 100 million t-CO2 per year. (Calculations by thr Heat Pump & Thermal Storage Technology Center of Japan.) ("Environmental Action Plan by the Japanese Electric Utility Industry" The Federation of Electric Power Companies, http://www.fepc.or.jp/english/env-action/action-plan2005.pdf, p14)	Accept – add sentence on heat pump

						(Shigeo Murayama, The Federation of Electric Power Companies)	
4-1292	A	64	11	0	0	Figure 4.3.19: improve the quality and explain the A-F in the figure! (Heleen de Coninck, Energy research Centre of the Netherlands)	See 4-1290
4-1293	A	65	5	65	11	Comparison between "combination of CCGT with advanced heat pump technology" and "conventional CHP plants fuelled by natural gas" in this context is not appropriate. Why only the natural gas fuelled conventional CHP is brought up for comparison is unknown. Both technologies are effective as regards to carbon emission reduction; therefore they shall be compared against conventional system (grid power and boiler combination). This text is misleading in a way that it give readers the impression that the CHP systems fuelled by natural gas are not efficient. In this context, it can be said that combination of natural gas fuelled CHP system using advanced fuel cell (eg. SOFC, MCFC) technology is also expected to reduce carbon emission for supplying heat when combined with heat pump compared to the system of CCGT and heat pump combined technology. (Satoshi Yoshida, The Japan Gas Association)	Accept – rewrite
4-1294	A	65	5	65	11	Geothermal heating from shallow resources (vertical or horizontal heat exchangers in soils; wells producing from local aquifers…) offer interesting solutions for housing heating with heat pumps. Already 70% of new housing are heated with that process in Sweeden, and ratios of 50% are reached in Germany and Switzerland. There is a huge potential for growth of such systems in Europe (e.g. 50% of the market of new houses i.e. 150.000 housing/year in France). Schemes can be made available to illustrate theses technologies (cf. brochure "La géothermie" BRGM – ADEME, 2005) (VARET jacques, French Geological Survey)	Accept – add sentence re geothermal
4-1295	A	65	5	65	11	Quantified comparison between a combination of CCGT with advanced heat pump and a natural gas-fueled CHP is often conducted as below. M.Saikawa, T.Hamamatsu, T.Mimaki and K.Hashimoto did so by using two indexes called "ECJI (Energy Chain Joule Index*1)" and "ECCI (Energy Chain Carbon Index*2)". "Energy Chain ―A New Concept in Evaluating Future Energy Conservation and Greenhouse Abatement Alternative and Effectiveness―" *1,2 ECJI ; Integral benefit on demand side (MJ)□Primary energy input (MJ), ECCI ; Integral benefit on demand side (MJ)□CO2 emissions (kg-C). The higher the index is, the more efficient or environmentally friendly it is. In the case of meeting electricity and heat demand, the scores on gas-fueled CHP	accept

						are 0.60 (ECJI) and 42.9 (ECCI) while those on advanced CCGT with heat pump (COP6) are 0.86 (ECJI) and 61.2 (ECCI). Furthermore, in the case of meeting electricity and hot water demand, the scores on PEFC are 0.66 (ECJI) and 47.2 (ECCI) while those on advanced CCGT with heat pump water-heater (COP4) are 0.88 (ECJI) and 62.8 (ECCI). (Shinichi Nakakuki, The Tokyo Electric Power Company)	
4-1296	A	65	5	65	11	This text is misleading in a way that it gives readers the impression that the CHP systems fuelled by natural gas are not efficient. (Government of Japan)	See 4-1291
4-1297	A	65	12	0	0	Oceanic sequestration is subjected to severe criticism by environmentalists and their concern must find mention since there are crtical reports on this subject investigated scientifically. (Government of India)	noted
CCS start							
4-1298	A	65	13	68	12	When discussing “underground” CO2 storage formations, please note that these are “deep” geologic formations. Communicating to the reader that a key criteria for whether a formation would be used to store CO2 is that it would be deep underground is very important. Please preface the word “deep” whenever talking about candidate geologic storage formations. (James Dooley, Battelle)	accept
4-1299	A	65	13	68	12	This entire subchapter on CCS is for the most part an eclectic grouping of various ideas about CCS. There’s no overarching point and the structure is not very clear. Why was this written in this way when it would have been far more productive and defensible to repeat what was recently published in the IPCC Special Report on CCS and update it as needed. Specific points that appear to be missing from AR4 when compared to the IPCC Special Report on CCS include: a discussion of variuos capture technologies (see paragraph 5, page 5 of the SPM for the IPCC SR on CCS as well as (see paragraph 16, page 10 of the SPM for the IPCC SR on CCS)), a differentiated discussion of ocean disposal (see paragraph 8, page 7 of the SPM for the IPCC SR on CCS), the geographic relationship between sources and sinks ((see paragraph 12, page 8 of the SPM for the IPCC SR on CCS), what sectors of the economy are most likely to use CCS systems and under what conditions (see paragraph 17, page 11 of the SPM for the IPCC SR on CCS), risks, leakage ((see paragraph 21-25 page 12-29) of the SPM for the IPCC SR on CCS), what is known about how to measure, monitor and verify stored CO2.....	Noted – but space limited and no new reference material

						(James Dooley, Battelle)	
4-1300	A	65	14	0	0	4.3.6 Carbon Capture and Storage (CCS): Is it 'Carbon Capture and Storage' or – like in IPCCs Special Report – 'Carbon Dioxide Capture and Storage'? (Manfred Treber, Germanwatch)	accept
4-1301	A	65	14	0	0	Title should be "Carbon dioxide capture and storage". (Heleen de Coninck, Energy research Centre of the Netherlands)	accept
4-1302	A	65	14	68	3	CO2 capture and storage (CCS) is a very important issue that merits a extensive discussion. I therefore support de detailed assessment and discussions included in the second order draft. I strongly suggest to discuss another dimension to the assessment: the amount of energy spent (or the loss of efficiency). The IPCC report on CCS includes the following estimates of energy consumption: 24 to 40% of final energy for Pulverized Coal plants and 14 to 25% for Integrated Gasification Combined Cycle plants (IPCC, Carbon Dioxide Capture and Storage, 2005, SPM p. 4). These estimates do not include the energy that would be required for long distance transportation. This spent energy can be used to calculate an Energy Payback ratio of power plants (also called "External Energy ratio" by the US National Renewable Laboratory). This ratio is the total energy produced during the life time of a plant, divided by the total energy required to build the infrastructures and to extract, process and deliver the fuel. The Energy Payback ratio of a typical coal plant without scrubbing can be about 6, down to 4 if the plant includes SO2 scrubbing, down to about 2 with CCS. This low ratio raise doubts on the feasibility of long distance sequestration. (Luc Gagnon, Hydro-Quebec)	Noted – but space limited and no new reference material
4-76	B	65	14	68	0	This section could be more clearly organized in a manner that reflects the findings of IPCC SRCCS. Suggest separate headings for CO2 capture, transport, and storage. The CO2 capture portion should include a discussion of various capture technologies (see page 5, paragraph 5 and page 10, paragraph 16 of the SPM to the SRCCS). Capture technologies with niche applications should not be covered in any detail. For transport, more detailed information could be included to explain IEA 2006 cost estimates (page 66, line 36). For example, what is "large volumes?" The storage portion should include a discussion of the various storage options covered in major chapter of the IPCC SRCCS, with less emphasis on those technologies that are either niche applications or need significant further testing. U.S. Government (Government of U.S. Department of State)	Noted – Heading of 4.3.6 is changed as you suggest "CO2 capture, transport, and storage". Technological and cost information on capture, transport and storage systems are included within space limited.

4-77	B	65	14	68	0	Although the IPCC SRCCS, 2005 is used as a source throughout this Section 4.3.6, it does not clearly convey the conclusions drawn and gives inappropriate emphasis to some new studies/technologies. The comments that follow are illustrative of this. IPCC is strongly encouraged to ensure consistency and demonstrate progress on this topic by adding a contributing author, someone involved in sythesizing the IPCC SRCCS, to this effort. U.S. Government (Government of U.S. Department of State)	Noted – but space limited and no new reference material
4-78	B	65	14	68	19	This chapter is biased in favor of CCS. It is very detailed (compared to CHP), but does not adequately mention local effect, risks, leakage, energy penalty, and storage potentials. (Government of Germany)	Noted – agreed
4-1303	A	65	15	65	23	CCS has the potential to capture, separate, transport and store CO2. CO2 used in CCS could be from both anthropogenic and/or natural sources. CO2 storage is more than just isolating CO2 from the atmosphere. CO2 that is injected into the subsurface will bypass the atmosphere and be reintroduced to the carbon cycle. Isolation suggests that CO2 will not do this and instead remain a plume. It is not just the 'capture of CO2' that can be best applied to large point sources. The entire CCS technology is most most applicable to large quantity CO2 emitters. Potential storage in underground geological formations suggest that it could happen, for example, 100m below surface. It should read "potential storage in deep, underground geological formations…" (Veronica Brieno Rankin, CH2M HILL)	Noted – but space limited and no new reference material
4-1304	A	65	15	68	0	Section 4.3.6: Options of CO2 capture (i.e., post-, pre- and oxyfuel combutions) and ocean storage (i.e., into water column and on the sea floor) should be added in order to show the outline of CCS technologies (These had been described in FOD). (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Noted – but space limited and no new reference material
4-1305	A	65	15	68	19	Section 4.3.6: The current text in the Second Order draft is an eclectic mix of commentary on CCS without really ever hitting the key points (e.g., about 25% of the AR4 text talks about how to define "capture ready", describes an interesting CO2 capture process that uses algae and discusses the role "air capture" systems, but there is no mention of which sectors of the economy might use CCS, what is known about the proximity of large point sources and candidate reservoirs, what do we know about measurement and monitoring technologies, is CCS "safe" etc). (Government of Environment Canada)	Accept "Capture ready description" will be shortened.

4-79	B	65	15	68	20	Section 4.3.6: no discussion on health, safety and (local) environment issues associated with CCS – see IPCC special report on CCS SPM. The authors should discuss risks more generally (see IPCC Special Report on CCS SPM and technical summary). (Government of Australia)	Noted – but space limited and no new reference material
4-1306	A	65	16	65	16	Insert IPCC before Special Report (John Kessels, Energy Research Centre of the Netherlands)	Accept
4-1307	A	65	17	65	18	Remove "best" and "electric". (Heleen de Coninck, Energy research Centre of the Netherlands)	Accept
4-1308	A	65	17	0	0	Maybe here, a statement indicating what the purpose of this section is can be included: "Because IPCC (2005a) already provides a recent overview of the state of CCS, this section will only report on new developments since the publication of the Special Report." (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – but space limited and no new reference material
4-80	B	65	17	65	20	Sentence discusses CO2 capture but there needs more discussion on the types of capture systems – i.e. pre-combustion, post-combustion, oxyfuel combustion and industrial separation. See IPCC Special Report on CCS Technical Summary discussion on "capture of CO2" (Government of Australia)	Noted – but space limited and no new reference material
4-81	B	65	17	65	20	Large point sources are described but there could be more discussion on which sectors will likely have opportunities to use CCS. For example refer to IPCC special report on CCS technical summary chapter 2 (sources of CO2). Discussion could include the different challenges and opportunities facing different sectors/industries in relation to incorporating CCS into commercial operations. (Government of Australia)	Noted – but space limited and no new reference material
4-1309	A	65	19	65	20	A cross-reference to Section 7.3.7, which discusses industrial applications of CCS, should be added to this text. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Noted – but space limited and the suggestion should be adopted in chapter 6.
4-82	B	65	19	65	20	A cross reference to Section 7.3.7, which discusses industrial applications of CCS, should be added to this text. U.S. Government (Government of U.S. Department of State)	See 4-1309
4-1310	A	65	20	0	0	There is strong language from nearly every government to abstain from ocean storage. There is a strong intention for geological storage, a refusal for ocean storage and there are as far as I know no plans for industrial fixation as inorganic	Noted – but space limited and no new reference material

						carbonates in higher volumes. The listing 'Potential storage methods include injection into underground geological formations, in the deep ocean or industrial fixation as inorganic carbonates' gives the impression that these methods are of comparable importance for CO2 storage.To avoid this wrong view please write 'Imaginable storage methods include ...' (Manfred Treber, Germanwatch)	
4-1311	A	65	20	65	23	The sentence mixes potential CCS technology at different stages, some at the pilot phase (aquifers and saline cavities) and some so controversial as not to be proposed by any government (deep ocean). The sentence should show this wide difference, e.g. "While some methods are now in a pilot phase such as injection of carbon dioxide in aquifers or saline cavities, other potentials are still speculative, such as deep ocean dumping or industrial fixation as inorganic carbonates." (ANTOINE BONDUELLE, Université Lille II)	Noted – but space limited
4-1312	A	65	20	0	0	Delete "that also produce CO2". (Heleen de Coninck, Energy research Centre of the Netherlands)	Accept
4-1313	A	65	21	65	21	Please add a phrase ' including Enhanced Oil Recovery and Enhanced Coal Bed Methane' after the word geological formation. Though these options have discussed in following pages, reader should know upfront about these economically feasible options of CCS. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	Accept – cross refernce
4-1314	A	65	22	0	0	Replace "biomass energy sources" with "biomass-fired installations". Delete "(such as when co-fired with coal)". Biomass-fired cogeneration plants are already mentioned earlier. (Heleen de Coninck, Energy research Centre of the Netherlands)	Taken into account "Biomass-fired " is deleted from the sentence on line 18.
4-1315	A	65	22	65	23	The description of "(such as when co-fired with coal)" should be deleted. The description of "biomass-fired electric power generation" exists on line 18 and this description will confuse readers. (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Taken into account "Biomass-fired " is deleted from the sentence on line 18.
4-1316	A	65	121	68	0	In general, there is very little discussion about the potential downsides of CCS such as: it will significantly increase the cost of coal plants, especially conventional, it won't capture all the CO2, the risk of migration/leakage, and the slight threat of induced seismicity. (Steve Clemmer, Union of Concerned Scientists)	Noted – but space limited and no new reference material
4-1317	A	65	0	68	0	In general, there is very little discussion about the potential downsides of CCS such	Noted – but space limited and no new

						as: it will significantly increase the cost of coal plants, especially conventional, it won't capture all the CO2, the risk of migration/leakage, and the slight threat of induced seismicity. (Steve Clemmer, Union of Concerned Scientists)	reference material
4-1318	A	66	1	66	1	Post-and pre-combustion are NOT commercially proven. The IPCC report (see SPM, page 4) clearly states that they are economically feasible under specific conditions (means that the technology is well understood and used in SELECTED commercial applications;...; with few – LESS THAN 5 – replications of the technology. (Gabriela Von Goerne, Greenpeace)	Noted – but space limited and no new reference material
4-1319	A	66	2	66	5	Although apparently evident, it may be worth mentioning explicitely (as is done in IEA, 2006, but also in the later chapters of this report) that power production with CCS will always be more expensive than the same plant without CCS. This is a main difference with almost all other alternatives that with time (technologic maturation) may become economic by themselves. (Government of Belgium)	Noted – but space limited and no new reference material
4-1320	A	66	3	0	0	This should mention the permanence concerns with geological storage. It could be modified as follows: "Research and development efforts conducted over the past decade have focussed on demonstrating the permanence of geological storage of CO2 and on underground monitoring techniques. Some promising options for... have also been identife." (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – but space limited and no new reference material
4-1321	A	66	4	66	5	The cost of using CCS will always be higher than the cost of venting CO2 to the atmosphere. Delete the phrase/concept "are still higher" unless you can point to literature that says otherwise. (James Dooley, Battelle)	accept
4-1322	A	66	5	0	0	Please add '...than power plants that emit CO2 into the atmosphere in the absence of a price for CO2 (IPCC, 2005a) ...' to make the conditions clearer. (Manfred Treber, Germanwatch)	accept
4-1323	A	66	6	66	7	The sentence 'Significant research regarding the biological impacts of ocean injection is needed before this option would be deployed (IPCC, 2005a)' gives the impression that after more research it would be clear that ocean storage is feasible. But there is a lot of new intelligence (e.g. on ocean acidification) which has convincing arguments that ocean storage could never be deployed. Please chose a formulation that is not deterministic that	Noted – but space limited and no new reference material

						ocean storage will be deployed. (Manfred Treber, Germanwatch)	
4-1324	A	66	6	66	9	Include reference on p.13 of Special Report on Carbon Dioxide Capture and Storage SPM before the statement on line 6: "Adding CO2 to the ocean or forming pools of liquid CO2 on the ocean floor at industrial scales will alter the local chmical environment. Experiments have shown that sustained high concentrations of CO2 would cause mortality of ocean storage. (Kirsten Macey, Climate Action Network Europe)	Noted – but space limited A part of risks is included.
4-83	B	66	7	66	7	Replace "would", which implies a certainty with "may" as ocean injection may never occur due to possible biological impacts and other barriers. (Government of Australia)	accept
4-1325	A	66	8	66	8	The dynamic nature of ocean storage requires not to use it for CO2 storage. The retention time is too low and the risk to harm the ocean eco-system much too high. The injection of a few GtCO2 would produce a measurable change in ocean chemistry in the region of injection, whereas the injection of hundrets of GtCO2 would produce larger measurable changes over the entire ocean volume (IPCC, SRCCS 2005).4.3.6 (Gabriela Von Goerne, Greenpeace)	Noted – but space limited and no new reference material
4-1326	A	66	10	66	11	Provide a reference for the statement that some mineral carbonation options have reached the demonstration phase. In the IPCC SRCCS it is still fully in the research phase. (Heleen de Coninck, Energy research Centre of the Netherlands)	accept
4-1327	A	66	13	66	16	This paragraph cites one study from the IEA that purports to show that CCS use will decline post 2050. Yet the IPCC Special Report on CCS concluded that "the role of CCS in mitigation portfolios increases over the course of the century (see page 12, paragraph 20 of the SPM for the Special Report on CCS, also note the figure on page 13)." Also note the diverse literature that is cited to substantiate this point in Chapter 8 of the Special Report on CCS. This one IEA study is not a sufficient basis to over turn one of the major findings of all the scientist who worked on the IPCC Special Report on CCS. (James Dooley, Battelle)	Noted – but space limited and no new reference material
4-1328	A	66	13	66	13	Suggestion: Replace the phrase "To allow the continued combustion of fossil fuels..." with "In modeling exercises of a carbon constrained world," Reason: The original phrase is not clear as written and subject to misinterpretation. It begs the question "Why would CCS be needed to allow the continued	Noted – reword

						combustion of fossil fuels" while the replacement text is consistent with the rest of the sentence that very clearly links to modeling efforts in which "CCS is projected...." (Russell Jones, API)	
4-1329	A	66	13	66	16	This para needs caveats and assumptions in order to have value. Of course, it assumes a carbon price. How much? What stabilisation scenario is used? What renewables are taking over? And don't most other models (see in the SRCCS) arrive at the conclusion that the application of CCS is still rising at the end of the century? How does that match with this statement? (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – reword
4-1330	A	66	13	66	21	You must provide some discussion of the limitations of CCS in the context of Article 2 of the UNFCCC, which is exactly what Harvey (2004) is all about. The key point that should be made is that, if 450 ppmv is adopted as an upper limit for the concentration of CO2 that avoids dangerous anthropogenic interference, and if we rely largely on CCS to stay within that limit, then even very small rates of leakage from terrestrial reservoirs or the geochemically guaranteed outgasing of about 15% of the CO2 injected into the deep ocean will cause CO2 concentrations to exceed 450 ppmv, thereby violating the UNFCCC. You should also discuss the global scale impacts of CO2 injection into the deep ocean on surface layer pH and carbonate supersaturation, as discussed in Harvey (2003). REFERENCES: Harvey, L.D.D. "Impact of deep-ocean carbon sequestration on atmospheric CO2 and on surface-water chemistry". Geophysical Research Letters 30(5), doi:10.1029/2002GLO16224, 2003. Harvey, L.D.D. "Declining temporal effectiveness of carbon sequestration: Implications for compliance with the United Nations Framework Convention on Climate Change", Climatic Change 63: 259-290, 2004. (Danny Harvey, University of Toronto)	Noted – but space limited and no new reference material
4-1331	A	66	13	66	13	Suggest replace of "To allow the continued combustion of fossil fuels.." with "To facilitate the deep cuts in emissions required…" (Christine Copley, World Coal Institute)	Taken into account
4-1332	A	66	13	66	16	IPCC SRCCS Figure SPM 7 does not support this description. This sentence should be changed.	Taken into account– ensure consistency with the special report

						(Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	
4-84	B	66	13	66	16	Information quoted from IEA report that CCS will "be deployed as a transition technology from 2015 onwards, peaking after 2050...then declining in the long term" appears to contradict the IPCC Special Report on CCS which states that "the majority of CCS deployment will occur in the second half of this century" (Technical Summary page 44). There is a need to at least identify this discrepancy and to discuss why scientific opinion has changed since the publication of the IPCC special report. (Government of Australia)	Accepted
4-85	B	66	13	66	16	This sentence, as written, is not consistent with the findings of the IPCC SRCCS. IPCC SRCCS concluded that the role of CCS would increase over the course of the century (see page 12, paragraph 20, of the SPM to the SRCCS). U.S. Government (Government of U.S. Department of State)	Taken into account– ensure consistency with the special report
4-86	B	66	13	66	16	"Under what scenario assumptions?" Clarify the scenario assumptions. U.S. Government (Government of U.S. Department of State)	Taken into account– ensure consistency with the special report
4-1333	A	66	17	66	35	Please delete this entire section on "capture ready" power plants. It doesn't really say anything and given the limited amount of space that AR4 will have to deal with CCS there are far more important topics to deal with. Also this notion that once a power plant is built it must always spew out the same level of CO2 or be retrofitted with CCS is not consistent with the most recent research looking at how dispatch-based economics might change the utilization rates for existing coal plants and that might be a more economic means of reducing emissions on this already built capital. Once could also look at co-firing with biomass. This section on "capture ready" is not needed and doesn't add anything to this short chapter on CCS. (James Dooley, Battelle)	Accepted
4-1334	A	66	17	66	35	It might be a good idea to make a section here "4.3.6.1 Capture-ready" (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – but space limited
4-87	B	66	17	66	35	This discussion of "capture-ready" is given too much empasis. There is no context provided and it appears completely out of the scope of this chapter. Recommend deletion. U.S. Government (Government of U.S. Department of State)	Accepted The senteces will be shortened.
4-1335	A	66	18	66	18	More accurate to insert an expected life of around 40-60 years See IEA, 2006:183 Energy Technology Perspectives	Noted

						(John Kessels, Energy Research Centre of the Netherlands)	
4-1336	A	66	19	0	0	Where is the evidence to say that "there is a move to consciously design such new plants to capture-ready"? (JUAN CARLOS ABANADES, INCAR-CSIC)	Noted
4-1337	A	66	19	66	20	This is a pretty academic discussion that fails to make the point that none of the conventional coal plants being built today (at least in the US, and probably in Asia) are anywhere near capture ready. This is a tremendous opportunity being lost right now and that should be noted. The statement about how "it might be important that capture equipment can be retrofitted" should be turned into a much more hard-hitting point about how these plants are locking-in to high emissions or high costs to control them. (Steve Clemmer, Union of Concerned Scientists)	Noted
4-1338	A	66	19	66	20	This is a pretty academic discussion that fails to make the point that none of the conventional coal plants being built today (at least in the US, and probably in Asia) are anywhere near capture ready. This is a tremendous opportunity being lost right now and that should be noted. The statement about how "it might be important that capture equipment can be retrofitted" should be turned into a much more hard-hitting point about how these plants are locking-in to high emissions or high costs to control them. (Steve Clemmer, Union of Concerned Scientists)	Noted
4-88	B	66	34	66	35	Sentence discusses access to geological storage. Needs greater discussion on source/sink matching. See IPCC special report on CCS SPM. (Government of Australia)	Noted – but space limited and no new reference material
4-1339	A	66	35	0	0	Also make this a subheading "4.3.6.2 CO2 transport" (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – but space limited and no new reference material
4-1340	A	66	37	0	0	CO2 transport is actually only used on such a scale in North America, not in other parts of the world. This might be worth mentioning. (Heleen de Coninck, Energy research Centre of the Netherlands)	accept
4-89	B	66	37	66	44	Paragraph discusses transportation of CO2 but there is no discussion on the geographical relationship between source and sink opportunities. Section could draw on IPCC special report on CCS SPM on "geographical relationship" at a minimum. (Government of Australia)	Noted – but space limited and no new reference material
4-1341	A	66	39	66	42	There is a mention of corrosion on line 41 in the pipeline context, but no mention of	Noted – but space limited and no new

						the corrosiveness that can result after the stuff is pumped into the ground. There was a study that came out after the IPCC CCS report that showed that the CO2 could cause some corrosion underground. (Steve Clemmer, Union of Concerned Scientists)	reference material
4-1342	A	66	39	66	42	There is a mention of corrosion on line 41 in the pipeline context, but no mention of the corrosiveness that can result after the stuff is pumped into the ground. There was a study that came out after the IPCC CCS report that showed that the CO2 could cause some corrosion underground. (Steve Clemmer, Union of Concerned Scientists)	Repeat of 4-1341
4-1343	A	67	1	0	0	Include section: 4.3.6.3 Geological storage (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – but space limited and no new reference material
4-1344	A	67	1	67	2	The sentence should be changed to "Geological storage of CO2 can be …" (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	accept
4-90	B	67	1	67	1	Sentence should explicitly state that this relates to "geological" storage. (Government of Australia)	accept
4-91	B	67	1	67	2	Sentence describes monitoring for CCS as being similar to oil and gas industry. Needs further discussion on the monitoring and verification requirements or the technologies/techniques involved to adequately monitor sequestered CO2. See IPCC Special Report on CCS technical summary. It would also be useful to highlight that a verification regime is an essential step for CCS to be adopted by the market – verification of sequestered CO2 is essential to provide assurances to the investment community. (Government of Australia)	Noted – but space limited and no new reference material
4-1345	A	67	3	67	4	Should this statement refer to the capacity of the storage formation or the scientific understanding of the formation. It is unclear refer to ch5 p.3 of the Special Report on CO2 CS "Capacity of unminable coal formations is uncertain". (Kirsten Macey, Climate Action Network Europe)	Noted – but space limited and no new reference material
4-1346	A	67	4	67	6	Insert: "However, recent research tends to indicate saline formations may require thorough assessment as to their long-term permanance and suitability for this purpose." See Kharaka et al: "Gas-water-rock interactions in Frio Formation following CO2 injection: Implications for the storage of greenhouse gases in sedimentary basins" Geology; July 2006; v. 34; no. 7; p. 577-580; (Pat Finnegan, Grian)	Noted

4-92	B	67	4	67	6	Sentence mentions trapping mechanism. This discussion could be enhanced to include all trapping mechanisms (eg physical and geochemical). There is also value in discussing the consequences/possibility of physical leakage. (Government of Australia)	Noted – but space limited and no new reference material
4-1347	A	67	5	67	13	For Germany, Vattenfall and RWE each have announced a CCS project in Eastern Germany and Western Germany. (Wilhelm Kuckshinrichs, Forschungszentrum Juelich GmbH)	noted – but space limited
4-1348	A	67	8	0	0	Offshore operations, not only offshore gas fields (Heleen de Coninck, Energy research Centre of the Netherlands)	Accept – oil and gas
4-93	B	67	8	67	8	"More projects in all kinds of reservoirs are planned. For example, …" Suggest adding between these two sentences a brief mention of the Carbon Sequestration Leadership Forum and its portfolio of projects. Suggest wording as "More projects in all kinds of reservoirs are planned. Several of these projects are contained within the activities of the Carbon Sequestration Leadership Forum, an international climate change initiative that is focused on development and deployment of improved cost-effective technologies for the separation and capture of carbon dioxide for its transport and long-term safe storage. For example, The Regional Carbon Sequestration Partnerships, led by the US and Canada have planned about 25 field tests over the next few years. …." U.S. Government (Government of U.S. Department of State)	Noted – but space limited and no new reference material
4-1349	A	67	9	67	14	Delete this text. My previous experience with writing IPCC reports is that it is generally inappropriate to cite what specific commercial firms are doing or are planning to do without placing these in some context. Its not the role of the IPCC to implicitly suggest that Shell, BP and others are "good companies" and are leading the way. It would be better to simply use the short paragraph on page 7 of the SPM for the Special Report on CCS that describes the current commercial projects and provides a definition of what constitutes a commercial project. (James Dooley, Battelle)	Taken into account Sentences are rewritten without any name of companies.
4-1350	A	67	9	67	12	For example, in Norway the possibilities to use captured CO2 from gas power plants and industry for enhanced oil recovery is investigated. At an early stage it is expected that governmental incentives will be needed to realise such projects. E.g. Statoil are planning an 860 Mwe gas-fired power plant and to also increase production at a methanol plant. Together with Shell they investigate the possibilities to use post-combustion captured CO2 in two norwegian offshore oil	Noted – but space limited

						fields storing 2.5 MtCO2/yr and increase oil production by an estimated 85% (Hileman, 2005). (Government of Norwegian Pollution Control Authority)	
4-1351	A	67	10	67	10	The methanol plant is not in Trondheim it is in Tjeldbergodden (John Kessels, Energy Research Centre of the Netherlands)	Noted
4-1352	A	67	10	0	0	The plant is in Tjeldbergodden, Norway. The Shell/Statoil project is called the "Draugen project". (Heleen de Coninck, Energy research Centre of the Netherlands)	See 4-1351
4-94	B	67	10	67	13	Delete detailed discussion of planned projects. Speculation about specific companies and their future plans are inappropriate for an IPCC report. U.S. Government (Government of U.S. Department of State)	Accept Sentences are rewritten without any name of companies.
4-1353	A	67	12	67	13	"BP is operating a gas processing CCS project in Algeria, where it injects the CO2 into the water layer in the gas field, and is planning two CCS-EOR projects in the United Kingdom and the United States." (Heleen de Coninck, Energy research Centre of the Netherlands)	Reject – specific commercial project
4-1354	A	67	15	67	16	Delete the first sentence of this paragraph. There really isn't a debate within the CCS community. Everyone agrees that we need better data and that better data will yield more precise estimates. There are other topics within the CCS community that are subjects of intense debate. This is simply not one of them. (James Dooley, Battelle)	Accept
4-1355	A	67	15	67	28	Include statement from Special Report on economic, environmental and safety considerations of storage options: "Similarly, to turn technical geological storage capacity into economical storage capacity, the storage project must be economically viable, technically feasible, safe, environmentally and socially sustainable and acceptable to the community. Given these constraints, it is inevitable that the storage capacity that will actually be used will be significantly less than the technical potential". IPCC Special Report on CO2 Capture and Storage (2005), p.200. (Kirsten Macey, Climate Action Network Europe)	Noted – but space limited and no new reference material
4-1356	A	67	15	67	28	When I interpret this paragraph correctly, it summarizes the results from the SR-CCS and then rejects them based on Bradshaw et al (2006). This is a highly conservative approach and the reader is left with no figure to go on. A wealth of reservoir estimates is available, and I suggest to give at least regional estimates (relative reliable numbers exist for e.g. the North Sea region) in order to illustrate	Noted – personal view

						the potential. Questioning sufficient capacity here is also problematic because the apparent problem is disregarded in following chapters. (Government of Belgium)	
4-95	B	67	15	67	16	Delete the first sentence of the paragraph. A difference of opinion in methodologies should not be construed as a major debate. U.S. Government (Government of U.S. Department of State)	Accept
4-1357	A	67	18	67	18	Replace "3-15 to 200 GtCO2" with "3 to 200 GtCO2" the range within a range doesn't make sense here. (James Dooley, Battelle)	Accept
4-1358	A	67	18	67	24	Delete everything between "Bradshaw" and "Dooley" in this paragraph. This point is at best footnote material. This is not nearly the interesting scientific topic that it is being made out to be here. Again, given the limited space available to discuss CCS there are far more important points that could be covered. For the average reader, it would be far more useful to cover whether there is likely to be enough CO2 storage potential for CCS to make a significant contribution to controlling emissions ((see paragraphs 18-19, page 12 of the SPM for the IPCC SR on CCS). The answer to that is an unequivocal "yes". That is far more important than a discussion about refinements to methodologies to compute available storage space. (James Dooley, Battelle)	Accept
4-96	B	67	18	67	0	Why 3-15 to 200 vs. 3-200? Change to "3 – 200". U.S. Government (Government of U.S. Department of State)	Accept – but the sentence will be deleted.
4-1359	A	67	29	0	0	Include section: 4.3.6.4 CO2 capture by algae (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – but space limited and no new reference material
4-1360	A	67	30	67	42	Delete. This is not an important aspect of what is likely to be the commercial deployment of CCS technologies. Please stick closer to the IPCC Special Report on CCS and what it covered. A lot of hard work went into that report and nothing here suggests that things have changed so much since the publication of the Special Report on CCS to warrant these tangents. (James Dooley, Battelle)	Taken into account The senteces will be shortened.
4-1361	A	67	30	67	43	This paragraph is out of context in this section on CCS. More important, it is of very poor quality, advertising some "exciting" new technologies with figures and references from a couple of websites that comercialize the technologies ¡ . There is a claim to "produce directly around 130000 l /ha" of biodiesel (I guess per year), against the 600 from soybean crops. I make a simple heat balance assuming 35MJ/l for the biofuel, and obtain a very very high efficiency in capturing solar	Taken into account See 4-1360

						energy and in trasnforming the algae to biodiesel. Has somebody checked these fiugres??, is there any peer-reviewed literature, supporting these extraordinary claims of efficiency?? ..... I reproduce here a paragraph much more balanced, that appears in the IPCC Special Report on CO2 Capture and Storage (2005): "As a CO2 capture technology, biomass production is ultimately limited by the efficiency of converting light into chemically stored energy. Currently, solar energy conversion efficiencies in agricultural biomass production are typically below 1% (300 GJ ha–1 yr–1 or 1 W m–2 (Larson, 1993)). Micro-algae production is operating at slightly higher rates of 1 to 2% derived by converting photon utilization efficiency into a ratio of chemical energy per unit of solar energy (Melis et al., 1998; Richmond and Zou, 1999). Hence the solar energy collection required for micro-algae to capture a power plant's CO2 output is about one hundred times larger than the power plant's electricity output. At an average of 200 W m–2 solar irradiation, a 100 MW power plant would require a solar collection area in the order of 50 km2."..... (JUAN CARLOS ABANADES, INCAR-CSIC)	
4-1362	A	67	30	67	42	Direct sequestration of carbon into soil is mentioned as "the other 50%" result of a process using algae to capture CO2.EPRIDA and others (www.terrapreta) have shown technical feasibility of using charcoal from pyrolisis for the same purpose.There is no other mention of soil sequestration as an alternative to both geological or oceanic/subseabed sequestration, There is no mention of pyrolysis-and-charcoal-sequestration in the biomass analysis in this chapter neither . (alberto pedace, Buenos Aires Univertsity)	Noted – but space limited and no new reference material
4-1363	A	67	30	67	42	These bioprocesses have been developed since the early stages of CCS developments, but the speeds are very far from the requirements and these processes are never main stream for CCS (It is clear if you read SRCCS). This paragraph will mislead readers and therefore should be deleted. (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Noted
4-1364	A	67	30	68	3	Too much space is devoted to rather "exotic" CCS technologies. Instead, it is usefull to introduce the principal technollogy routes for carbon capture: Post-combustion, Pre-combustion, and Oxy-Fuel. (Wilhelm Kuckshinrichs, Forschungszentrum Juelich GmbH)	Noted
4-1365	A	67	30	0	42	The information in the para is relevant but it needs additional information concerning cost predictions and the technologies' maturity.	Noted

						(Government of Sweden)	
4-1366	A	67	30	67	42	These description of bioprocesses are never main stream for CCS. This paragraph will mislead readers and therefore should be deleted. (Government of Japan)	Accept
4-97	B	67	30	68	5	The discussion of the capture component of CCS should logically be moved to before the discussion of storage and transport. (Government of Australia)	Noted
4-98	B	67	30	67	42	It is not appropriate to dedicate an entire paragraph of this short section to this technology. This was not an important topic covered in the SRCCS and it is given too much weight here. Recommend deletion or summarizing the concept in no more than 1-2 sentence. U.S. Government (Government of U.S. Department of State)	Accept
4-99	B	67	30	67	42	too detailed. Shorten to one sentence. Instead, explain post combustion, pre combustion and oxyfuel as promising options. (Government of Germany)	Accept
4-1367	A	67	39	0	0	Replace “reduced by half” with “halved”. (Heleen de Coninck, Energy research Centre of the Netherlands)	Accept
4-1368	A	67	40	67	42	Anaerobic chemoautotrophic methanogens convert CO2 into methane without help of sunlight in underground aquifer(“underground methane factory”). (Koide H,1999 Geological sequestration and microbiological recycling of CO2 in aquifers, in B.Eliasson, P.Riemer & A.Wokaun eds.: Greenhouse Gas Control Technologies, Proc. GHGT-4, Pergamon, p.201-205) (Koide H and Yamazaki K,2001 Subsurface CO2 Disposal with Enhanced Gas Recovery and Biogeochemical Carbon Recycling, Environmental Geosciences Vol.8 , No:3, p.218-224) (Hitoshi Koide, Waseda University)	Noted – but space limited and no new reference material
4-1369	A	67	43	0	0	Include section: 4.3.6.5 Air capture of CO2 (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – but space limited and no new reference material
4-1370	A	67	44	68	3	Delete. Again the air capture technologies are best niche applications. In the limited space AR4 is going to devote to CCS please stick to truly consequential issues that readers need to understand. (James Dooley, Battelle)	Accept
4-1371	A	67	44	68	3	Capture of CO2 from air was considered in Chapter 3, but disregarded from further analysis because “the CO2 concentration in ambient air is around 380 ppm, a factor of 100 or more lower than in flue gas” and from well established principles in	Noted

						chemical engineering, and comon sense, it was concluded that "Capturing CO2 from air by the growth of biomass and its use in industrial plants with CO2 capture is more cost-effective based on foreseeable technologies". I think these two sentences reflect better the status of knowledge about capture of CO2 from air, and I think the IPCC should not give much more coverage to this option until the experimetnal data and rigurous information on energy use and engineering costs is available (the lack of these is correctly pointed out in the last sentence of the paragraph (JUAN CARLOS ABANADES, INCAR-CSIC)	
4-1372	A	67	44	68	3	See also Baciocchi et al, Analysis of a Process for Carbon Dioxide Capture from Air, Greenhouse Gas Control Technologies Conference (GHGT-8), Trondheim, 2006 for less optimistic predictions concerning energy requirements for air capture. (Kenneth Möllersten, Swedish Energy Agency)	noted
4-100	B	67	44	68	3	It is not appropriate to dedicate an entire paragraph of this short section to this technology. This was not an important topic covered in the SRCCS and it is given too much weight here. Recommend deletion or summarizing the concept in no more than 1-2 sentence. U.S. Government (Government of U.S. Department of State)	noted
4-1373	A	67	45	67	46	After "proposed" insert "Keith and Ha-Duong, 2003)" before "but" add "and that infertile land can be used, e.g. injection into depleted oilfields in desert regions, providing mitigation of dispersed emissions from vehicles" (Peter Read, Massey University)	noted
4-1374	A	67	45	67	46	After "proposed" insert "Keith and Ha-Duong, 2003)" before "but" add "and that infertile land can be used, e.g. injection into depleted oilfields in desert regions, providing mitigation of dispersed emissions from vehicles" (Peter Read, Massey University)	repeat
4-1375	A	67	46	68	3	This paragraph should be deleted, because this chapter exists for the descriptions of energy supply but this paragraph does not have any relationship to energy supply systems. (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	noted
4-1376	A	67	46	68	3	This description is not useful, because these concept does not have any relationship to energy supply systems. We suggest to this paragraph should be deleted. (Government of Japan)	noted

4-1377	A	68	0	68	0	Table 4.3.5 add new row "Capture from biomass fermentation//$5/tCO2 // applies to high purity source requiring only drying and compression" [[maybe not much for compression if fermentation is not inhibited by pressurising sugar solution before evolution of CO2 gas – anyone know the answer to that? – I'm afraid I don't]] (Peter Read, Massey University)	Noted – but no reference
4-101	B	68	1	68	1	energy requirement: What does 30 % refer to? (Government of Germany)	Accepted – find out what the 30% means
4-1378	A	68	4	0	0	Renumber existing to 4.3.6.2 and insert new sub-head "4.3.6.1 Bioenergy with carbon storage"//new line// "CCS can also be linked to bioenergy to give a negative emissions energy system (Obersteiner et al, 2001) such as would be needed if abrupt climate change becomes imminent (Read and Lermit, 2005, Read and Parshotam, 2006 (under review)). The prospectivity of regions that may become major biofuel producers has been found to be likely somewhat limited in some cases, particularly sub-Saharan Africa (Haszeldine, 2006) where an alternative way of storing carbon long term could prove to be important. This is to treat the soil with biochar (finely divided 'charcoal' e.g. co-produced with liquid biofuels by flash pyrolysis) which has an in-soil half life of several thousand years and can confer increased fertility to the soil, due to the biochar acting as a substrate for microbial and fungal activity conducive to healthy rooting (Ogawa et al 2006, Lehmann et al 2006, Lehmann, 2006a, Day et al 200x, Marris 2006). This so-called 'terra preta nova' technique is claimed to have eventual (2100) potential to store 35GtCO2eq/yr out of the atmosphere. (Peter Read, Massey University)	Noted – but space limited
4-1379	A	68	4	68	4	Renumber existing to 4.3.6.2 and insert new sub-head "4.3.6.1 Bioenergy with carbon storage"//new line// "CCS can also be linked to bioenergy to give a negative emissions energy system (Obersteiner et al, 2001) such as would be needed if abrupt climate change becomes imminent (Read and Lermit, 2005, Read and Parshotam, 2006 (under review)). The prospectivity of regions that may become major biofuel producers has been found to be likely somewhat limited in some cases, particularly sub-Saharan Africa (Haszeldine, 2006) where an alternative way of storing carbon long term could prove to be important. This is to treat the soil with biochar (finely divided 'charcoal' e.g. co-produced with liquid biofuels by flash pyrolysis) which has an in-soil half life of several thousand years and can confer increased fertility to the soil, due to the biochar acting as a substrate for	repeat

						microbial and fungal activity conducive to healthy rooting (Ogawa et al 2006, Lehmann et al 2006, Lehmann, 2006a, Day et al 200x, Marris 2006). This so-called 'terra preta nova' technique is claimed to have eventual (2100) potential to store 35GtCO2eq/yr out of the atmosphere. (Peter Read, Massey University)	
4-1380	A	68	4	68	4	Until here, CCS for post combustion has been discussed. Here, a paragraph is needed to discuss the pre-combustion CCS options. (Ghulam Rasul ATHAR, Pakistan Atomic Energy Commission)	noted
4-1381	A	68	5	68	20	The discussion needs to be expanded to cover the cost differential between capturing carbon from IGCC plants and from conventional plants. Given all the conventional plants being built, this is a huge problem. The table lumps all coal plants together, failing to make the distinction at all. (Steve Clemmer, Union of Concerned Scientists)	Noted – but space limited and no new reference material
4-1382	A	68	5	68	20	The discussion needs to be expanded to cover the cost differential between capturing carbon from IGCC plants and from conventional plants. Given all the conventional plants being built, this is a huge problem. The table lumps all coal plants together, failing to make the distinction at all. (Steve Clemmer, Union of Concerned Scientists)	repeat
4-1383	A	68	5	68	12	The costs numbers need some explanation. First of all, it should be stated what the fuel prices are which these costs have assumed. The can be of great influence on particularly the capture costs. Secondly, the table in the IPCC report had much more detail in the caption. For instance the notion that the costs in Table 4.3.5 cannot be added up. Also, the section should include something on the overall expected costs of CCS – according to the IPCC SRCCS 25 to 30 US$/tCO2. (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted – but space limited and no new reference material
4-1384	A	68	5	0	0	Modify: 4.3.6.6 Costs (Heleen de Coninck, Energy research Centre of the Netherlands)	Noted
4-1385	A	68	5	0	0	Under the costs 4.3.6.1, the cost range appears bit wide since this is based on current costs only. For example, a range of 15-75 USD/T of CO2 for capture looks so large a range that it may not mean much. The process of capture may be mentioned for these range of costs. (Government of India)	Noted
4-102	B	68	5	68	20	Need more discussion here. For example, page 66, line 5, includes a reference to costs (USD0.01-0.05/kWh). That should also be mentioned here with a detailed discussion of what is included in these costs. For example, do that estimate include	Noted – but space limited and no new reference material

						monitoring and verification costs? U.S. Government (Government of U.S. Department of State)	
4-1386	A	68	7	68	20	Please make an overview of all planned projects and also state the barriers for implementation on the short term for CCS. (Government of European Community / European Commission)	Noted
4-103	B	68	10	68	12	Note uncertainty in storage costs due to uncertainty of time scale of monitoring and verification. U.S. Government (Government of U.S. Department of State)	Noted
4-1387	A	68	14	68	20	This table needs the following note: These costs are all based on 2002 fossil fuel prices. The IPCC SR on CCS says, "Increases in market prices of fuels used for power generation would generally tend to increase the cost of CCS." (IPCC 2005A) SPM p. 10 (Steve Sawyer, Greenpeace International)	Noted
4-104	B	68	15	38	20	Geo. storage M&V costs may be on the low end due to time scale uncertainty. U.S. Government (Government of U.S. Department of State)	Noted
4-1388	A	68	19	0	0	There have been recent policy developments for CCS which may be reported here. The IPCC has come up with the "2006 Guidelines for Inventories" which for the first time offers an internationally accepted framework for reporting on geological storage in national inventories. The SBSTA has organised a workshop on CCS and CDM in response to three methodologies (two geological storage, one ocean storage) and to discussions in the MOP. The EU ETS is considering CCS as an eligible technology and the European Commission is working on a regulatory framework. (Heleen de Coninck, Energy research Centre of the Netherlands)	noted

CCS end

4-1389	A	68	20	72	15	Section 4.3.7 would be better placed as 4.3.4 5 on page 63,line 5 and followed by a section 4.3.4.6 devoted to the distribution problems of energy generated by intermittent sources (Government of France)	Reject - editorial
4-1390	A	68	24	68	26	This is incorrect. The caption for Figure 4.3.21 shows transmission and distribution losses as 4% for fossil fuels, 7% for nuclear, which normally would not be considered "high".	accept

						(Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	
4-105	B	68	24	68	26	This is incorrect. The caption for Figure 4.3.21 shows transmission and distribution losses as 4% for fossil fuels, 7% for nuclear, which normally would not be considered “high”. U.S. Government (Government of U.S. Department of State)	repeat
4-1391	A	68	0	0	0	Table 4.3.5 add new row "Capture from biomass fermentation//$5/tCO2 // applies to high purity source requiring only drying and compression" [[maybe not much for compression if fermentation is not inhibited by pressurising sugar solution before evolution of CO2 gas -- anyone know the answer to that? - I'm afraid I don't]] (Peter Read, Massey University)	noted
4-106	B	69	1	69	0	Figure 4.3.21 “Convert to percentage of primary fuel on energy basis” Suggestion to find a better figure for portraying T&D losses U.S. Government (Government of U.S. Department of State)	noted
4-107	B	69	10	69	13	The sentences in the paragraph are disconnected. The second sentence, the example—which describes capacities, does not follow from the statement in the first sentence—which is about generation and capacity factor. U.S. Government (Government of U.S. Department of State)	Accept – change capcity to capacity factor in l12
4-1392	A	69	13	0	0	Pls. Add after system. Further reduction potential could be utilised by application of e.g.low loss transformers, low loss and extremely compact and safe switchgear and substations, newly developed equipment for reactive power compensation at transmission and distribution levels, IT based flexible altenating current transmission systems (FACTS) and HV-DC links. Suggest to consider this also for the TS. (Friedrich Plöger, Siemens AG)	Noted – but space limited and no new reference material
4-1393	A	69	15	69	25	The IEA's 2003 World Energy Investment Outlook (Chapter 7, Electricity, page 339) states that investment in transmission networks requires particular attention. Although it concludes that higher investments in transmission will be required because of increased use of 'intermittent renewables'. It also states that the increased use of distributed energy, in the reference scenario will save around $130 billion between 2001 and 2030 (mainly in the OECD). In its 'OECD Alternative Policy Scenario' (p403, 404) which is based around energy efficiency and renewable energy lowers transmission costs by 40% and distribution costs by 36%, thus despite capital intensive renewable energy, the overall scenario is around 20%	accept

						less than the reference scenario, becoming more pronounced over the longer term. This factor needs integrated into chapter as it is both relevant for cost analysis section (4.4.2 pages, starting page 76), and decision-making sequencing, if those cost savings are to be captured (by decision-making sequencing I mean influencing energy infrastructure investment decisions in the nearer term as raised in Chapter 3). (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	
4-1394	A	69	27	69	29	incorporate hydrogen as both a cryogenic coolant and an energy carrier seems to be an utopia (Government of France)	Reject – but reference chancy star of epri
4-1395	A	70	1	0	0	A sentence should be added making reference to Superconducting Fault Current Limiters as a means towards improving grid stabiity and avoiding black-outs. Such devices are now under development in several coountries (amongst them the USA, Germany, Japan, South Korea, Israel and some are already connected to the grid. (Guy Deutscher, Tel Aviv University)	Noted – but space limited and no new reference material
4-1396	A	70	8	0	0	"Section 4.3.7.1 Decentralized energy. Comment. With reference to a future feasible Distributed Energy System, the 2004 EPRI presentation -Generation Technology Choices: Near and Long Term- shows a very comprehensive figure that include in the tomorrow's grid also the Vehicle-to-grid power (V2G) that uses electric-drive vehicles (battery, fuel cell, or hybrid vehicles) to provide power for specific electric markets. I suggest to include the V2G option in the DES description of the section 4.3.7.1 Decentralized energy. Also, considering the strategic relevance of the 4AR WGIII IPCC Report, especially in the medium and long term, I underline the importance that great attention is paid to the analysis of innovative solutions regarding the possible use of new products. In particular, I think to the possible use of Fuel Cell Vehicles (FCV) as a new power-generation source, supplying electricity to homes and to the grid like a new different type of Distributed Generation, especially at peak times (Vehicle-to-Grid – V2G). This innovative use of FCV could be able to reduce the costs related to the introduction of the new products, and will represent a huge amount of new installed peak power generation capacity. In fact, based on U.S. U.S. Policy Energy Act of 2005 data, in 2020, on 2,5 million FCV (little more than 1% of the U.S. vehicles stock), will be installed (based on 80 Kw stack) 200 GW of V2G power generation capacity, i.e. 21% of the U.S. total	accept

						power generation installed capacity in 2003 (EIA data). More general data are available in V. Romeri 2004 paper -Hydrogen: a new possible bridge between mobility and distributed generation (CHP).- References: 1) EPRI – S. Gehl: Generation Technology Choices: Near and Long Term. U.S. DoE EIA Annual Energy Outlook Conference. Washington DC, 2004. Available on the Web at <http://www.eia.doe.gov/oiaf/archive/aeo04/conf/pdf/gehl.pdf >, Page 15. 2) California Air Resources Board: Vehicle-to-Grid Power: Battery, Hybrid, and Fuel Cell Vehicles as Resources for Distributed Electric Power in California. California Environmental Protection Agency 2001. Available on the Web at <http://www.udel.edu/V2G/V2G-Cal-2001.pdf >. 3) W. Kempton, J. Tomi: Vehicle-to-grid power fundamentals: Calculating capacity and net revenue. Journal of Power Sources 144 (2005) 268–279. Available on the Web at <http://www.udel.edu/V2G/KempTom-V2G-Fundamentals05.PDF >. 4) V. Romeri: Hydrogen: a new possible bridge between mobility and distributed generation (CHP). 19th World Energy Congress. Sydney 2004. Available on the Web at <http://www.worldenergy.org/wec-geis/congress/papers/romeriv0904.pdf >. 5) U.S. Policy Energy Act of 2005, Public Law 109-58. 8 Aug. 2005. Available on the Web at <http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_public_laws&docid=f:publ058.109.pdf>. 6) EIA Annual Energy Outlook 2005. Available on the Web at <http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2005).pdf>." (Mario Valentino Romeri, none - private Italian citizen)	
4-1397	A	70	10	72	6	Need to also outline the barriers of decentralized energy. (John Kessels, Energy Research Centre of the Netherlands)	Accept – not reliable, more expensive, limited in power
4-1398	A	70	14	70	16	Chage the sentence, "Such systems can play an important role in lowering GHG emissions from the electricity sector but fossil fuel systems based on reciprocating engines can also have benefits over main grid connections." to "Although renewable energies such as wind and solar power generation needs measures in connecting to the grid, it is expected that these energies will lower GHG emissions. However, caution should be necessary to the fact that decentralized energy systems that use fossil fuels, especially mono-generation, will emit more CO2 compared to power grid system that contains such as nuclear and hydroelectricity power units.	Accept

						Merits of DES are as follows;" <Rationale> Although there are various kinds of DESs, not all of them have environmental merits. For the case of simple mono-generation that are popular in Japan, CO2 emissions tend to increase and hence above-mentioned concerns should be described. (Shigeo Murayama, The Federation of Electric Power Companies)	
4-108	B	70	15	70	0	"…fossil fuel…not just fossil fuel; internal combustion/recip. engines can run on locally produced biofuels" U.S. Government (Government of U.S. Department of State)	accept
4-109	B	70	19	70	19	"Rural also; other factors—sustainable development/rural jobs impact" U.S. Government (Government of U.S. Department of State)	accept
4-1399	A	70	20	70	20	The following text is deleted from the earlier version. Please tell us why it is deleted. The general use of DES could fundamentally change the relationship between power suppliers and consumers and, in time as usage increases, also the network architecture of the overall power distribution system. The concept is to use a myriad of renewable and fossil fuel resources in numerous small-scale heat and power generating systems to meet local demands. Such technological infrastructure could enable the two-way flow of power and information and enable competitive markets to develop for a broad range of distributed services. Technology development in the near and intermediate term will be focused on the demonstration of advanced DES technologies, particularly "hybrid" systems that, for example, could integrate high efficiency fuel cells with advanced micro-turbines. (Masahiro Nishio, Ministry of Economy, Trade and Industry)	Noted – but space limited and no new reference material
4-110	B	70	27	70	0	"…fossil fuels…or bio" U.S. Government (Government of U.S. Department of State)	accepted
4-1400	A	70	29	70	29	Should read 'Zero-carbon, renewable energy sources such as solar, wind and biomass are widely distributed" (Steve Sawyer, Greenpeace International)	accept
4-111	B	70	29	70	0	"…wind and bioresources are…" U.S. Government (Government of U.S. Department of State)	See 4-1400

4-1401	A	70	31	70	32	Add another bullet to indicate that DRE reduces GHG emissions that would occur from production of material for strucutres. (Norbert Nziramasanga, Southern centre for Energy and Environment)	Noted – but space limited and no new reference material
4-1402	A	70	33	70	47	Japan is promoting the use of natural gas fueled CHP in order to meet Kyoto Protocol. Target is 4980MW by the year of 2010 to reduce 11.4 mil ton CO2. (http://www.kantei.go.jp/foreign/policy/kyoto/050428plan_e.pdf see Appendix17) Power generated from these CHPs' will substitute grid power supplied by fossil fuelled generation technologies. (Satoshi Yoshida, The Japan Gas Association)	accept
4-1403	A	70	33	71	18	Section 4.3.5 should be cross-referenced here, along with the points that I raised in my comment to page 64. (Danny Harvey, University of Toronto)	noted
4-1404	A	70	33	70	47	Japan is promoting the use of natural gas fueled CHP in order to achieve Kyoto Protocol. Target is 4980MW by the year of 2010 to reduce 11.4 mil ton CO2. Reference: http://www.kantei.go.jp/foreign/policy/kyoto/050428plan_e.pdf see Appendix17 (Government of Japan)	repeat
4-1405	A	70	39	70	39	Suggest inserting sentence, "In Finland, 50 per cent of space heating is provided by CHP" (Statistics Finalnd (2005), Energiatilasto 2004) (Steve Sawyer, Greenpeace International)	Reject – wrong place
4-1406	A	70	48	0	0	The following text is deleted from the earlier version. Please tell us why it is deleted. Despite the various benefits of DES using renewable energy sources for small scale cooling and heating applications, many barriers to its deployment remain, including regulations that protect the monopoly of utilities, and other rules; - difficulty for an IPP in connecting to the grid or using non-utility lines - prevention of distribution utilities from owning and operating generation capacity - utility's requirements on standby charges, lost revenue, and connection fees, that add substantial costs. There is a major opportunity to re-examine these barriers and encourage DES to be deployed in order to lower fossil fuel emissions and renewable generated electricity. The World Bank and bilateral aid agencies could also support this technology due to the role that decentralized and non-grid based networks can play in reducing poverty and vulnerability to climate change impacts (Johansson and Goldemberg, 2002; Practical Action, 2005). Decentralized renewable energy	Noted – but space limited

						systems can stabilize the ecological and social determinants of climate change vulnerability as well as help mitigate emissions (Venema & Cisse, 2004) and 'democracy' gains through increased participation in decision-making processes and self-determination can result (WWF, 2004) (Masahiro Nishio, Ministry of Economy, Trade and Industry)	
4-1407	A	71	8	71	8	"……pipeline, section 4.3.1.4……". Incorrect reference to the section 4.3.1.4 (Government of India)	accept
4-112	B	71	10	71	0	Hydrogen-fueled internal combustion engines are positioned to provide an efficient, near zero emission, cost effective near term conversion technology. This technology cannot be overlooked. Hydrogen fueled ICE's are also tolerant of impurities, providing a demand for lower purity hydrogen than that required for fuel cells. This will provide a pull while the production technology matures. U.S. Government (Government of U.S. Department of State)	accept
4-113	B	71	11	71	0	"Batteries (compressed air)". Add "compressed air" U.S. Government (Government of U.S. Department of State)	accept
4-114	B	71	20	71	24	This growth was primarily related to the "telecom bubble" as fossil fuel recip. engines were the fastest, least expensive alternative. New research indicates interest and benefits of alternative configurations—see Robinson, Arent e.t. all (2005) http://www.nrel.gov/docs/fy06osti/40220.pdf) U.S. Government (Government of U.S. Department of State)	Noted – but off the point
4-1408	A	72	15	0	0	Section 4.4.3: The entire section is based on a dibious methodology both in terms of cost and CO2 mitigation. It should be deleted. (Christian Kjaer, European Wind Energy Association)	Noted – but no references
4-1409	A	72	15	0	0	oil prices have raised substantially in the last year, and it is not likely that they will decrease in the future. So it will be useful to add few lines on this. It seems that most of the evaluations are based on literature of 2005 or 2004, that does not consider this point (i.e. pag. 30 line 23 ...oil prices much higher than 20$ per barrel). It is important to explain if the 70 $ per barrel could change all the analyses in this chapter (and in the chapter 4,4,2 and 4,4,3) (Stefano Caserini, Politecnico di Milano)	Noted – need to reference WEO2006 figures

Comments on sections 4.4.1 – 4.4.2 Inga

4-1410	A	72	15	92	0	Section 4.4: There will be a lot of overlaps the precedent sections. You should arrange the overlaps. (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Noted
4-1411	A	72	25	74	24	This is a poor presentation of the general idea that the future energy system out to 2030 might evolve in different ways. The mixing of a number of different reference cases and control cases particularily in Figure 4.4.1 likely leaves the reader with the impression that nothing useful can be said about how the future might evolve. Also the fact that the SRES scenarios did not include CCS is not suprising. CCS is an explicitly climate mitigation technology, there is no (or very, very little) reason to use it absent controls on greehnouse gas emissions. So even if the SRES scenarios "would have included CCS" it still wouldnt have deployed as those are reference cases. It would be far more informative to rewrite this section and focus on what the literature tells us about the major drivers that will impact how the energy system will deploy and which emissions mitigation technologies are adopted and the extent of their adoption. See for example sections 8.3.1.2 and 8.3.2.1 of the IPCC Special Report on CCS for a discussion of what the literature tells us about what are the major drivers for technology adoption in the face of greenhouse gas constraints. (James Dooley, Battelle)	Noted
4-1412	A	72	37	72	44	Note on scenarios: I assume you will be using the new information in the WEO 2006 which will be made available to you soon. I should also note that a scenario developed jointly with DLR (German Aerospace Center), the European Renewable Energy Council and Greenpeace will be made available to you as soon as it is submitted for publication. This preliminary results of this scenario are referenced in both the Greenpeace/GWEC "Global Wind Energy Outlook and EPIA/Greenpeace 'Solar Generation 2006', both of which are submitted along with these comments. (Steve Sawyer, Greenpeace International)	Accepted - WEO 2006 will be used
4-115	B	72	37	72	44	It is stated that, "Neither higher energy prices (as experienced in 2005/06) and projections that they will remain high (section 4.3.2.3), nor current assessments of CCS deployment rates (section 4.3.5) were included in the IEA and SRES scenarios." If this is the case, when were the IEA and SRES scenarios produced? Why were more recent projections not used? The large shift in relative prices we have recently experienced will have a dramatic effect on these projections, as an example witness the large variations between AEO 2005 and AEO 2006. U.S.	Noted

						Government (Government of U.S. Department of State)	
4-1413	A	73	1	0	0	Figure 4.4.1 The author points out that ARABE scenarios are parhaps more useful for evaluating future energy systems than IEA and SRES scenarios in that they account for current energy higher prices and CCS opotunities (page 72 line 43, page 73 line 6). Though I'm not familiar with these model, I'd like to make two remarks about this point. (1)The 2030 timeframe dsiscussed here, CCS would not play a important role. There are little difference between ARABE Tech scenario and ARABE TECH+CCS scenario in this figure. Therefore, IEA scenarios and SRES scenario, enen though they do not take CCS opotunities into account, are still useful in this sense. (2)What's the reason for that CO2 emmisions of the ARABE scenarios (ex. 51.7GtCO2/yr in 2030 in Tech Scenario), which do consider higher oil prices and higher rate of technological advancements and energy conservation, are much higher than those of SRES and IEA scenarios? (,)	Noted (1) Accepted (2) – will be clarified
4-1414	A	73	1	0	0	In figure 4.4.1, why are the CO2 emissions for the last three columns greater than in the reference scenario while the energy use is smaller? (Danny Harvey, University of Toronto)	Accepted – will be clarified
4-1415	A	73	1	73	4	Figure 4.4.1: The scale along Y-axis and the values written above the bars are not consistent. Some clarification is required. (Muhammad Latif, Applied Systems Analysis Group)	Rejected – it is explained under the figure
4-116	B	73	1	73	5	Figure 4.4.1: Please check the data underlying the ABARE scenarios as the emissions seem to be for ALL greenhouse gases not CO2 only. The Ref scenario should be 48.4 Mt CO2, Tech = 43.5 Mt CO2 and Tech+CCS = 40.2 Mt CO2 - pages 104 & 105 of Matysek et al (2006). As a double-check total EJ/yr at 2030 are 662 EJ under the Ref, 618 EJ under the Tech and 622 EJ under the Tech+CCS scenarios (Figure 29, page 58 in Matysek et al 2006). (Government of Australia)	Accepted – will be checked
4-1416	A	74	5	74	7	Natural gas plants achieving efficiencies of 75% and coal plants achieving efficiencies of 65-66% is well beyond any estimates I've seen, except for CHP plants. (Steve Clemmer, Union of Concerned Scientists)	Noted
4-1417	A	74	5	74	7	Natural gas plants achieving efficiencies of 75% and coal plants achieving	Noted

						efficiencies of 65-66% is well beyond any estimates I've seen, except for CHP plants. (Steve Clemmer, Union of Concerned Scientists)	
4-1418	A	74	9	74	15	The results of the quoted "Tech+CCS" scenario: the costs of non hydro technologies whilst will decline not more than 10% until 2030, should not be accepted in this assessment report, as this has already proven to be incorrect. (Sven Teske, Greenpeace International)	Noted – this is assumption of "Tech+CCS" scenario
4-1419	A	74	12	74	13	An assumed 10% reduction in the cost of renewables is very pessimistic. Projected cost reductions for wind, biomass IGCC, and particularly solar are much higher than this. (Steve Clemmer, Union of Concerned Scientists)	Noted – this is assumption of "Tech+CCS" scenario
4-1420	A	74	12	74	13	An assumed 10% reduction in the cost of renewables is very pessimistic. Projected cost reductions for wind, biomass IGCC, and particularly solar are much higher than this. (Steve Clemmer, Union of Concerned Scientists)	Noted – this is assumption of "Tech+CCS" scenario
4-117	B	74	13	0	0	"…10%" - how is this related to historical learning? Need to provide more explanation. U.S. Government (Government of U.S. Department of State)	Noted – this is assumption of "Tech+CCS" scenario
4-1421	A	75	0	75	0	Figure 4.4.2 should be deleted. It is not readable,unclear and almost does not pass any useful information. (Government of China Meteorological Administration)	Rejected – the quality of figure will be improved
4-1422	A	75	1	75	0	Difficult to read figure 4.4.2 perhaps increase the size of the font (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-1423	A	75	1	0	0	Fig. 4.4.2 suggests that only 5005 EJ of conventional oil will be used by 2030 (say 980 billion barrels) which is low by comparison to some projections of demand. (Michael Jefferson, World Renewable Energy Network & Congresses)	Noted – will be checked
4-118	B	75	1	75	0	Figure 4.4.2 should be deleted for all the same reasons given for Figure 4.2.1, as used above. U.S. Government (Government of U.S. Department of State)	Rejected
4-1424	A	75	3	0	0	Figure 4.4.2 Figure is of very poor quality and should be replaced with a higher resolution figure or be deleted. (Sven Teske, Greenpeace International)	Accepted - the quality of figure will be improved
4-119	B	75	4	75	5	The note states that "The ratio by which Fast reactor technology increases the power generation capability per tonne of natural uranium varies greatly from the	Noted

						latest OECD assessment of 30:1 based on a rather detailed fuel-cycle analysis to 167:1." The use of the 30:1 ratio should be assumed in preference to the ratio of 167:1 for several reasons: -The "rather-detailed fuel cycle analysis" referred to in the text is an undocumented study performed by a handful of U.S. laboratories and has not released nor received meaningful review by industry, nor academia nor other interested groups of experts. The OECD results were produced by a multinational team using transparent and traditional processes to review and gain consensus. -The 167:1 ratio is, in any case, misapplied to this assessment. The 167:1 ratio is based on an assumption of extensive use of depleted uranium stockpiles over very long time periods. No nation in the world is proposing or contemplating the extensive use of depleted uranium by the 2030 timeframe, which is the analytical timeframe that this figure explicitly states. U.S. Government (Government of U.S. Department of State)	
4-1425	A	75	0	0	0	Figure 4.4.2. The same comment as on Figure 4.2.1 (page 12) applies to Figure 4.4.2. See my comment on Figure 4.3.2 on page 32. (Jan Willem Storm van Leeuwen, Ceedata Consultants)	Accepted - the quality of figure will be improved
4-1426	A	76	1	76	0	Columns in table need to be aligned (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-1427	A	76	1	0	0	In the caption to Table 4.4.1, indicate what scenario is being shown here and give a reference. (Danny Harvey, University of Toronto)	Accepted – ref. will be added
4-1428	A	76	1	76	1	Table 4.4.1, what scenario is this? How does this relate to other scenarios mentioned and to Chapter 3? (Government of European Community / European Commission)	Accepted – will be clarified
4-120	B	76	1	76	1	Source for material presented in Table 4.4.1 should be added. Rationale: Given the number of comparative sources used in this chapter, especially in section 4.4, it would be helpful for the reader to have the table sources clearly cited—not only here, but throughout. U.S. Government (Government of U.S. Department of State)	Accepted
4-1429	A	76	7	0	0	I have made this comment for other chapters as well but I believe we need to introduce more on what a "cost" actually means. The subject is broached here but I think more should be added. In earlier editions of Assessment Reports (and perhaps this one too - I have not read all the chapters), we see definitions of costs and what is included in costs. I'm not sure what we are looking at here (except that	Noted

						it is some sort of levelized cost or strict financial cost at a couple of low discount rates. But what might the costs look like if we use typical corporate decision making criteria with short payback periods and / or high returns on investments? What would it take, cost wise, to get energy suppliers to move to more expensive, more efficient technologies? If one does analyses not include hurdle rate types of discount rates, could readers be mislead into thinking that one can quite effectively reduce emissions as per table 4.4.4 for the cost prices listed?. Further to this, what is the likelihood of actually attaining such reductions given the variability in the agents in the supply market? This may be "potential reductions" but what does "achievable" look like? 90% of this? 75%? less than half? (John Nyboer, Simon Fraser University)	
4-1430	A	76	7	79	0	Springer, (2003), Laurikkaa and Springer, (2003) and Springer and Laurikkaa, (undated), St. Gallen apply MVP techniques to quantify and minimize the portfolio risk of a set climate change mitigation policies. More recently, MVP has been used in various aspects of electricity capacity planning (Awerbuch and Dimitropoulos 2007, Awerbuch May 2006, Krey and Zweifel, 2005, Awerbuch, Jansen and L. Beurskens (2004); Awerbuch and Berger 2003; Berger 2003; Awerbuch 2000a; Awerbuch 1995a) and the valuation of renewables targets (Awerbuch, January 2006; Delaquil, Awerbuch and Stroup, October 2005). In these applications MVP results consistently support theoretical expectations suggesting that optimal generating mixes must include larger shares of wind, geothermal and other fixed-cost renewables even where the assumed cost for these technologies is higher than the cost of gas and coal generation. Optimal MVP mixes enhance energy security while simultaneously minimizing expected generating cost and risk. (Shimon AWERBUCH, SPRU - University of Sussex)	Noted
4-1431	A	76	7	79	0	Section 4.4.2 Cost Analyses -- P 76. and other sections dealing with cost appraisal Modern finance theory, (i.e. the Sharpe-Lintner Capital Asset Pricing Model or CAPM) represents a important improvement in asset-valuation that provides a new, and to many, a surprising picture of the relative cost-effectiveness of conventional and renewable generating alternatives. For a variety of reasons policy makers and energy analysts have been slow to adopt these into their analyses (Awerbuch, Dillard, et. al. 1996). As a consequence, energy policy is formulated on the basis of cost estimates that do not benefit from contemporary valuation principles (Shimon AWERBUCH, SPRU - University of Sussex)	Noted

4-1432	A	76	7	79	0	Section 4.4.2 Cost Analyses -- P 76. and other sections dealing with cost appraisal IEA (Cost of Generating Electricity, 2005), along with other agencies (e.g. DTI, US-EIA) publish generating kWh estimates based on century-old engineering kilowatt-hour (kWh) cost models. The IEA (2005) engineering estimates discussed in this section ignore risk (the relevance of risk in energy an climate is discussed in Chapter 2) and improperly perpetuate the idea that gas-fired combined-cycle is the "cheapest." They tell us little about the true cost of generating with gas relative to wind or nuclear and should be given little if any probative weight in policy (Awerbuch, July-August 2006, 2003, 2000, 1995, 1933). (Shimon AWERBUCH, SPRU - University of Sussex)	Noted
4-1433	A	76	7	79	0	Section 4.4.2 Cost Analyses -- P 76. and other sections dealing with cost appraisal Engineering cost models suggest that gas is cheaper, insofar as it will produce more kWh for a given projected level of capital, operating and fuel costs. But gas-fired generation is not cheaper; it is simply riskier. Financial investors understand this idea. They routinely analyze, for example, investments in low-risk government bonds as compared to high-risk, high-yield corporate bonds, commonly called "junk bonds." Junk bonds promise a higher return for a given level of investment but also carry a higher risk that the promised return may not materialize. Such risk differences explain why a junk bond with an expected annual yield of around 8%, (€80 per €1000 invested) trades at the same market price as a US government bond with an expected yield of only €40 per year per €1000 invested. Although the junk bond promises twice the payout, investors recognize its speculative nature and hence will not pay more for it than they would for a 'safe' government bond that pays only half as much each year. (Shimon AWERBUCH, SPRU - University of Sussex)	Noted
4-1434	A	76	7	79	0	Section 4.4.2 Cost Analyses -- P 76. and other sections dealing with cost appraisal CAPM-based models suggest that the expected cost of gas-fired generation over the next 25 years is 75% higher than the IEA (2005) results and well in excess of the CAPM-based cost of wind (Figure 4-1). Although they are based on the same set of projected fuel and other cost inputs, the CAPM estimates use market-derived discount rates that yield kWh cost estimates with a precise economic interpretation: they provide a conservative proxy of the long term fixed-price bids investors would submit for generating electricity. (Shimon AWERBUCH, SPRU - University of Sussex)	Noted
4-1435	A	76	7	79	0	Investors in gas generation, however, do not worry as much about the risk of	Noted

						fluctuating gas prices since these are more readily passed on to customers, potentially leading to more investment in gas generation than may optimal from a societal perspective (Awerbuch, 2006, Roques, 2006). Neither investors nor government cost estimates seem to reflect the speculative nature of gas and other fossil fuels. (Shimon AWERBUCH, SPRU - University of Sussex)	
4-1436	A	76	7	79	0	Finally, Awerbuch, Stirling, Jansen and Beurskens (2006) explore the limitations of the MVP approach and compare MVP optimal generating mixes to 'maximum diversity' mixes (see Stirling, 1994, 1996) that also insulate against uncertainty, ignorance and 'surprise.' They find that optimal mixes in both cases contain larger shares of wind. REFS – Chap 4 Awerbuch, S. and Dimitropoulos, J. 2007, "Efficient electricity portfolios for Europe," European Investment Bank 2007 Series in Economics and Finance: An Efficient, Sustainable, and Secure Supply of Energy for Europe S. Awerbuch, (July-August 2006) "Risky Business - The Economic Case for Renewables: Fossil Risk Mitigation and Enhanced Energy Security" Renewable Energy World, July-Aug. Awerbuch, S. and Sauter, R. (2006) "Exploiting the oil–GDP Effect to Support Renewables Deployment, Energy Policy, Vol. 34 pp. 2805-2819. Awerbuch, S. (May, 2006) "Portfolio-Based Electricity Generation Planning: Policy Implications for Renewables and Energy Security," Mitigation and Adaptation Strategies for Global Change, Volume 11, Number 3 (May) Awerbuch, S., Stirling, A. C., Jansen J., and Beurskens, L., (2006) "Portfolio and Diversity Analysis of Energy Technologies Using Full-Spectrum Risk Measures," in: D. Bodde, K. Leggio and M. Taylor (Eds.): Understanding and Managing Business Risk in the Electric Sector, Elsevier Topics in Global Energy Regulation, Finance and Policy. S. Awerbuch, J. Jansen and L. Beurskens 2004, "Building Capacity for Portfolio-Based Energy Planning in Developing Countries," REEEP-UNEP-BASE, August, http://www.sefi.unep.org/fileadmin/media/sefi/docs/reeep_porfolioplanning.doc S. Awerbuch, 2003 "Determining the real cost: Why renewable power is more cost-competitive than previously believed," Renewable Energy World, March-April, 2003 www.jxj.com/magsandj/rew/2003_02/real_cost.html	Accepted

						Awerbuch, S. "The True Cost of Fossil-Fired Electricity in the EU: A CAPM-based Approach," Power Economics, (May, 2003) Awerbuch, S. 2003 "Is gas really cheapest?" Modern Power Systems, June 2003 Awerbuch, S. and M. Berger, Feb-2003 Energy Security and Diversity in the EU: A Mean-Variance Portfolio Approach, IEA Report Number EET/2003/03, Paris: February (2003) http://library.iea.org/dbtw-wpd/textbase/papers/2003/port.pdf Awerbuch, S., (2000) "Investing in Photovoltaics: Risk, Accounting and the Value of New Technology," Energy Policy, Special Issue, Vol. 28, No. 14 (November) Awerbuch, S. (2000a) "Getting It Right: The Real Cost Impacts of a Renewables Portfolio Standard," Public Utilities Fortnightly, February 15, 2000. Awerbuch, S., Dillard, J., Mouck, T., and Preston A., 1996 "Capital Budgeting, Technological Innovation and the Emerging Competitive Environment of the Electric Power Industry," Energy Policy, Vol. 24, No. 2, February, (1996), 195-202. Awerbuch, S. 1995 "Market-Based IRP: It's Easy!" The Electricity Journal, Volume 8, No. 3, (April) 1995 Awerbuch, S. (1995a) "New Economic Cost Perspectives For Valuing Solar Technologies," in, Karl W. Böer, (editor) Advances in Solar Energy: An Annual Review of Research and Development, Vol. 10, Boulder: ASES, 1995 Awerbuch, S., 1993 "The Surprising Role of Risk and Discount Rates in Utility Integrated-Resource Planning," The Electricity Journal, Vol. 6, No. 3, (April) 1993. Bar-Lev, D. and S. Katz, 1976 "A Portfolio Approach to Fossil Fuel Procurement in the Electric Utility Industry," Journal of Finance, 31(3) June, 933-47 Berger, Martin, 2003, Portfolio Analysis of EU Electricity Generating Mixes and Its Implications for Renewables, Ph.D. Dissertation, Technischen Universität Wien, Vienna, March Delaquil, Pat, Awerbuch, Shimon, Stroup, Kristin, Dec-2005 "A Portfolio-Risk Analysis of Electricity Supply Options in the Commonwealth of Virginia," Chesapeake Climate Action Network, Dec. 2005, http://chesapeakeclimate.org/doc/VA_RPS_Portfolio_Study_Report-Final_Updated.doc Fabozzi, Frank, Francis Gupta and Harry Markowitz (2002) "The Legacy of modern Portfolio Theory," The Journal of Investing, Fall, 7-22, Institutional Investor, Inc Bolinger, Mark, Ryan Wiser, and William Golove, (2004) "Accounting for Fuel	

						Price Risk When Comparing Renewable to Gas-Fired Generation: The Role of Forward Natural Gas Prices," Energy Policy. Hattori, Toru "An Application of Portfolio Theory to Fuel Choice in Japanese Electricity Industry," Tokyo, 2005, forthcoming in S. Awerbuch (Ed) Portfolio-Based Electricity Planning: Enhancing Energy Diversity and Security, Elsevier, 2007. Helfat Constance E., (1988) Investment Choices in Industry. Cambridge, MIT Press. Humphreys, H. Brett and K. T. McLain, (1998) "Reducing The Impacts of Energy Price Volatility Through Dynamic Portfolio Selection," Energy Journal, 19, (3) Kleindorfer, Paul R. and Lide Li, "Multi-Period, VaR-Constrained Portfolio Optimization in Electric Power," The Energy Journal, January 2005, 1-26 Krey, Boris and Zweifel, Peter, "An Efficient Energy Portfolio for Switzerland," Working Paper, Socioeconomic Institute, University of Zurich, March, 2005 Laurikkaa, Harri, Springer, Urs "Risk and return of project-based climate change mitigation: a portfolio approach," Global Environmental Change 13 (2003) 207–217. Lesbirel, Hayden (2004) Diversification and Energy Security Risks: the Japanese Case, Japanese J. of Political Science Markowitz, Harry (1952): 'Portfolio selection', J. Finance, 7(1), 77-91 Seitz, Neil and M. Ellison, 1995 Capital Budgeting and Long-Term Financing Decisions, Dryden Press Roberts, Michael J. and Larry Dale, "Discount Rates and Energy Efficiency Standards," USDA Economic Research Service and Lawrence Berkeley National Laboratory, University of California at Berkeley, (unpublished), July 2004 Sidorenko, N. Baron M. and M. Rosenberg (2002) "Estimating oil price volatility: A GARCH Model," Energy Power Risk Management, October Springer, Urs and Harri Laurikka, "Quantifying risks and risk correlations of investments in Climate Change Mitigation," IWOe Discussion paper No. 101, University of St. Gallen; ISBN 3-906502-98-8 www.iwoe.unisg.ch/org/iwo/web.nsf Springer, Urs 2003, "Can the risks of Kyoto mechanisms be reduced through portfolio diversification: evidence from the Swedish AIJ Program," Environmental and Resource Economics, 25(4): 501-513, August 2003. Stirling, Andrew C., 1996 On the Economics and Analysis of Diversity, Paper No.	

						28 Science Policy Research Unit (SPRU) University of Sussex, www.sussex.ac.uk/spru Stirling, Andrew C. 1994 "Diversity and Ignorance in Electricity Supply Investment: addressing the solution rather than the problem," Energy Policy, 22(3). (Shimon AWERBUCH, SPRU - University of Sussex)	
4-1437	A	76	7	81	34	This section needs to clarify that issues like transmission and distribution (T&D) savings, depending on energy technology used; and also the wider economic benefits of utilising renewable energy, or other non price-volatile fuels, utilising finance portfolio theory which takes into account the cost of the 'risk' of price volatility; and findings that renewables are counter-cyclical (for example, Awerbuch, S. and Sauter, R., 2005a. Exploiting the Oil-GDP effect to support Renewables Deployment. [online] Paper No. 129, SPRU Electronic Working Paper Series. Available from URL http://www.sussex.ac.uk/spru/). These factors need recognised in this section, and are relevant in other sections where energy-related mitigation costs are being compared. (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	Accepted
4-1438	A	76	7	0	0	Section 4.4.2 Although a caveat is provided at the start of the section, it should be repeated throughout, especially where data is provided in tables. Some discussion of energy prices in the caveat should also be addressed - typical oil price assumptions in models was $20 per barrel - which has no bearing on todays prices. This needs to be clearly stated where prices/costs are discussed. (Christine Copley, World Coal Institute)	Accepted
4-1439	A	76	10	76	11	The sentence sounds too negative for developing countries only, when it looks like developed countries did the same in the past and went to chose the "cheapest option regardless of environmental impact" (JUAN CARLOS ABANADES, INCAR-CSIC)	Noted
4-1440	A	76	14	0	0	Do you mean achieve a capacity factor of 80% or provide 80% of baseload capacity ie generation? For example, the contribution of hydro to total generation in NZ is now more like 65% depending on inflows. (Michael Taylor, International Energy Agency)	Noted – will be checked
4-1441	A	76	14	76	16	Please remove the sentence on capacity factors. Again, this sentence does not consider the issue of peak demand. In Japan, a large portion of electricity generation comes from nuclear power plants, who do not have the ability to quickly increase or decrease their generation. As a result, hydro plants have large excess capacity, to meet demand fluctuations. In fact, Japan is a leader in pumped storage	Accepted

						hydro plants, which consume more electricity than they produce, in order to have reserve power for periods of very high demand. A pumped storage plant has a negative capacity factor, and this is not a problem: it is designed with such a characteristic. This option is often chosen because it is the lowest cost option to insure peak demand service. (Luc Gagnon, Hydro-Quebec)	
4-121	B	76	14	76	0	"…capacity factors…future fuel prices!" Include "future fuel prices" U.S. Government (Government of U.S. Department of State)	Accepted
4-1442	A	76	20	76	20	O&M ? Add references or specification (Stefano Caserini, Politecnico di Milano)	Accepted – will be specified
4-1443	A	76	0	79	0	By reflecting risk, CAPM models produce more reliable generating cost estimates. Yet these estimates are still not fully satisfactory for planning electricity capacity since they do not help us determine the best generating mixes. Rather than focusing on the 'stand-alone' generating costs, we need to focus on the cost and risk of alternative generating portfolios. Modern Portfolio Theory (MVP) is widely used to optimise financial portfolios (Fabozzi, Gupta and Markowitz [2002] and Varian [1993]) and has also been applied to problems involving real assets, e.g. capital budgeting (Seitz and Ellison 1995), valuing off-shore oil-leases (Helfat, 1988); establishing optimal generating fuel mixes, (Hattori, 2006, Humphreys and McLain 1998 and Bar-Lev and Katz 1976); optimizing real (physical) and derivative electricity trading options (Kleindorfer and Li, 2005), and evaluating energy security issues (Lesbirel 2004). (Shimon AWERBUCH, SPRU - University of Sussex)	Noted
4-1444	A	77	1	77	12	The low end of the cost range in Figure 4.4.3 is considerably lower than recent estimates I've seen. Total 20-yr levelized costs are more in the range of $50-70/MWh for supercritical pulverized coal plants, $65-80/MWh for gas combined cycle (mainly from recent increases in gas prices), and $60-70/MWh based on recent data from Black & Veatch and EIA. (Steve Clemmer, Union of Concerned Scientists)	Noted – will be checked according to the ref.
4-1445	A	77	1	77	12	The low end of the cost range in Figure 4.4.3 is considerably lower than recent estimates I've seen. Total 20-yr levelized costs are more in the range of $50-70/MWh for supercritical pulverized coal plants, $65-90/MWh for gas combined cycle (mainly from recent increases in gas prices), and $65-80/MWh for nuclear	Noted – will be checked according to the ref.

						based on recent data from Black & Veatch and EIA. (Steve Clemmer, Union of Concerned Scientists)	
4-1446	A	77	6	0	0	Please recheck cost figures as CCGTs are supposed to be costlier (Ajay Guha, Asian Development Bank)	Accepted
4-1447	A	77	7	77	9	The capital cost assumptions are considerably lower than recent estimates I've seen. Recent estimates by Black & Veatch, a major construction and engineering firm in the US, claims capital costs for new supercritical coal plants are $1,780/kW (2006$) based on an average cost of 60 plants either under construction or with air permits in a database they maintain; nuclear capital costs of $2,550/kW today declining to $2,300/kW by 2030 based on the costs of recent projects in Japan and Europe, and gas combined cycle capital costs of $620/kW. A proposed 600 MW coal plant in SD (Big Stone II) recently announced that the capital costs for the project would increase from ~$1,670/kW to $2,250/kW. There is some evidence that the cost for coal and other technologies has increased significantly over the past few years due to increases in steel, copper, concrete, fuel and other commodity prices, labor costs, and demand for components and labor that have created shortages. These recent prices increases are clearly illustrated in a slide from the Puget Sound Energy, a utility in Washington state, which put out a request for proposals for new generation in 2004 and 2006. Let me know if you would like me to send this information to use in the report (Steve Clemmer, Union of Concerned Scientists)	Accepted
4-1448	A	77	7	77	9	The capital cost assumptions are considerably lower than recent estimates I've seen. Recent estimates by Black & Veatch, a major construction and engineering firm in the US, claims that overnight capital costs for new supercritical coal plants are $1,780/kW (2006$) based on an average cost of 60 plants either under construction or with air permits in a database they maintain; nuclear capital costs of $2,550/kW today declining to $2,300/kW by 2030 based on the costs of recent projects in Japan and Europe, and gas combined cycle capital costs of $620/kW. These costs do not reflect interest during construction, which can significantly add to the cost. Even the high end of the range of nuclear plant costs are below the current costs recent projects. Nuclear should also include a risk premium above the discount rates assumed for the other technologies. A proposed 600 MW coal plant in SD (Big Stone II) recently announced that the capital costs for the project would increase from ~$1,670/kW to $2,250/kW. There is some evidence that the cost for coal and other technologies has increased significantly over the past few years due	Accepted

						to increases in steel, copper, concrete, fuel and other commodity prices, labor costs, and demand for components and labor that have created shortages. These recent prices increases are clearly illustrated in a slide from the Puget Sound Energy, a utility in Washington state, which put out a request for proposals for new generation in 2004 and 2006. Let me know if you would like me to send this information to use in the report (Steve Clemmer, Union of Concerned Scientists)	
4-122	B	77	7	77	11	The waste management and disposal, refurbishing and decommissioning costs may have been accounted for in all the cost studies but the example of the decommissioning costs is very low. Current UK estimates place their decommissioning costs at fifty times the figure provided per kilowatt. (Government of Australia)	Rejected – no reference
4-123	B	77	13	77	23	At what fuel cost assumption? Reference footnote on details or remove. U.S. Government (Government of U.S. Department of State)	Accepted – will be checked
4-1449	A	77	21	77	23	We strongly disagree with this conclusion that nuclear is economically justified. Using more reasonable costs estimates and factoring the other security, safety, waste disposal, and poliferation risks of nuclear power would justify using a high risk premium and cost. (Steve Clemmer, Union of Concerned Scientists)	Noted
4-1450	A	77	21	77	23	We strongly disagree with this conclusion that nuclear is economically justified. Using more reasonable costs estimates and factoring the other security, safety, waste disposal, and poliferation risks of nuclear power would justify using a high risk premium and cost. (Steve Clemmer, Union of Concerned Scientists)	Noted
4-1451	A	78	3	78	3	When it comes to compare cost, it is very important to be transparent about capacity factors assumed for nuclear and fossil based power generation. These should be indicated. (JUAN CARLOS ABANADES, INCAR-CSIC)	Accepted
4-1452	A	78	3	78	5	Suggest adding at the end of this sentence, "…a larger role, but the costs to the state for support of liability, decommissioning, long term storage and remediation costs as well as societal costs associated with increased proliferation risk need to factored in as well. (Steve Sawyer, Greenpeace International)	Accepted
4-1453	A	78	6	78	6	I don't know why the graph points are connected by a broken line - there are no	Accepted

						trends, as such and it looks confusing. (John Nyboer, Simon Fraser University)	
4-124	B	78	8	78	0	Figure 4.4.4. Where is wind or other RETs? Replace chart if another is available that includes renewable energy technologies. U.S. Government (Government of U.S. Department of State)	Noted
4-1454	A	78	13	0	0	I don't think that the statement beginning "This emphasized …. " is correct. In all of the assessments of externalities that I have looked at, direct human health impacts are the dominant contributor to the total externality, not assigned costs of climatic change. However, I have not read the particular assessment cited here. (Danny Harvey, University of Toronto)	Noted
4-1455	A	78	13	78	14	Not being familiar with this EU study, it is not possible to comment with confidence on its treatment of the external costs of nuclear energy. However, the results shown in Figure 4.4.5 (p 79) suggest that the external costs of nuclear energy are seriously underestimated. Although nuclear energy might not be a great emitter of GHG, there are other external costs, including the risk of major accidents and the disposal of radioactive waste. The costs of major accidents are potentially enormous, so they should not be dismissed lightly. (Kenichi Oshima, Ritsumeikan University)	Rejected
4-1456	A	78	15	78	15	Section 4.3.6 is for CCS (John Kessels, Energy Research Centre of the Netherlands)	Accepted – correct section number 4.3.5
4-1457	A	78	15	0	0	This is interesting, but we need to know more about the basis of the study. For instance, what did the EU assume for the external cost of CO2 and is this always the most important exrternal cost? What other external costs were taken into account? just list them. (Michael Taylor, International Energy Agency)	Accepted – will be clarified
4-1458	A	79	1	79	1	The figure needs more definition re: "rest", "Power Plant" and especially what an external cost is. (John Nyboer, Simon Fraser University)	Accepted – will be clarified
4-125	B	79	1	79	15	The authors should explain whether Figure 4.4.5 is relevant only to the EU as it is based on region-specific information from Europe, or if the figure has more general applicability. (Government of Australia)	Noted
4-1459	A	79	2	0	0	Figure 4.4.5 In this figure nuclear power has almost no external costs. After the dramatic Chernobyl accident this assumption is proven to be wrong. A footnote?	Noted

						(Sven Teske, Greenpeace International)	
4-1460	A	79	6	79	16	Legal and regulatory environmental framework, as well as the practice of environmental authorities to license new conventional energy projects, are key factors for the transition from conventional to renewable energy pattern. (Demóstenes Barbosa da Silva, AES Brazil)	Noted
4-1461	A	79	8	79	9	"Costs to….primary energy resources…"Insert 'would' after 'primary energy resources' (Government of India)	Accepted
4-1462	A	79	9	79	11	The important question is not how big the probable fossil fuels are but how much can be used at a given cost. While environmental impacts from combustion will be a major driver in the transition to non-carbon energy sources, increasing energy prices, security issues with nuclear power and LNG, and other environmental and public health impacts of mining, transporting and using fossil fuels will also be important. (Steve Clemmer, Union of Concerned Scientists)	Noted
4-1463	A	79	9	79	11	The important question is not how big the probable fossil fuels are but how much can be used at a given cost. While environmental impacts from combustion will be a major driver in the transition to non-carbon energy sources, increasing energy prices, security issues with nuclear power and LNG, and other environmental and public health impacts of mining, transporting and using fossil fuels will also be important. (Steve Clemmer, Union of Concerned Scientists)	Noted
4-1464	A	79	11	79	13	the sentence "Renewable energy and uranium resources are in sufficient supply to meet future global primary energy demands (Figure 4.4.1)." is out of context here (Stefano Caserini, Politecnico di Milano)	Accepted – figure 4.4.1 not related with this sentence
4-1465	A	79	12	79	13	Uranium resources are limited to roughly 75 to 100 years, wherea renewbale energy is unlimiteted.It is not justified to mention both of them together by saying „in sufficient supply". (Gabriela Von Goerne, Greenpeace)	Noted
4-1466	A	80	0	80	0	Footnote 7 is misplaced (does not refer to solar PV). (Government of Sweden)	Accepted – will be checked
4-1467	A	80	1	0	0	Table4.4.2 Add a row of concentrating solar to the column : take numbers given in chapter 4.3.3.5 and under my comment on page 23, line 1 (Robert Pitz-Paal, German Aerospace Centre (DLR))	Accepted

4-1468	A	80	1	0	0	Table 4.4.2: It is not at all clear what is meant by "Technical Potential to 2050." In fact the information provided is misleading. For example, it is not technically credible that nuclear fission could produce 400,000 EJ of power by 2050, even with fuel reprocessing, due to the doubling time of fission breeders. It also contradicts the value presented in table 4.3.1. Similarly it is not technically credible that coal could produce 130,000 EJ by 2050, and this number contradicts 4.3.1 as well. This column is not relevant to the material in this section, and should be dropped. (Robert Goldston, Princeton Plasma Physics Laboratory)	Accepted – will be clarified
4-1469	A	80	1	0	0	Table 4.4.2 Indices from Solar PV and Biomass are wrong – this table does not fit together with the figure from table 4.3.1, page 23 and is therefore contradictory. (see above) (Sven Teske, Greenpeace International)	Accepted – will be checked
4-1470	A	80	1	0	0	Table 4.4.2: Why to make an exception and omit an estimation on solar thermal as if there were no number for the Technical potential to 2050 for solar thermal? If you look at page 52, lines 17 and 18 in chapter 4 there is a hint for the potential of solar thermal power plants. (Manfred Treber, Germanwatch)	Accepted – will be checked
4-1471	A	80	1	0	0	Table 4.4.2 --- Is the 80,000 TW " technical potential" of solar PV to 2050, the result of multiplying 1600 TW times 50 years? If so, perhaps this should be made clear in a note to the table. (Christopher Green, McGill University)	Accepted – will be checked
4-1472	A	80	1	0	0	Table 4.4.2. Please check the cost ranges for coal vs natural gas. Coal seems too expensive compared to natural gas. Also note that superscritpt 7 should not be in the line for "Solar PV" (JUAN CARLOS ABANADES, INCAR-CSIC)	Accepted – will be checked
4-1473	A	80	1	0	0	Table 4.4.2- cost data should same units (Ajay Guha, Asian Development Bank)	Rejected
4-1474	A	80	1	80	1	This table (4.4.2) has all of the same problems as identified with table 4.3.1 on page 23 above, the information is not consistent between the two tables, and the sources used are unclear, and I believe that some of the problems are caused by using reports with some methodological differences and different aged data. All of these combine to present a misleading picture of the relative merits and demerits of various technologies. I believe both of these tables need to be reworked to: a) clearly separate the end uses that are being serviced: heat, electricity, transport; when technologies are compared, they need to be in commensurate units, the	Accepted – will be checked

						distinction between ACTUAL costs and projected costs needs to be clear, and should be in commensurate units and units which make sense - EJ for electricity production is not meaningful. Costs and emissions for TWh produced is. Costs and emissions for a joule of useable heat is useful. Also, not sure what happend to notes 1-3, but cannot find a referent for 1&2 so perhaps it is only 3 that is missing. Also, note 7 is misapplied to Solar PV...but was there another note supposed to go there? (Steve Sawyer, Greenpeace International)	
4-1475	A	80	1	0	0	Table 4.4.2. I have several problems with this table including: 1) there are some inconsistencies in the cost data with Table 4.3.1; 2) the low end of the projected investment costs are way too low for natural gas, coal, wind, geothermal, and biomass; 3) the project generation costs are low for natural gas, coal and nuclear, 4) some of the notes in technical potential column for solar PV and biomass don't make sense. (Steve Clemmer, Union of Concerned Scientists)	Accepted – will be checked
4-1476	A	80	1	0	0	Table 4,4,2The numbers quoted on potential to 2050 and implied new construction contradict a survey made by independant researchers which show that a growth of 18 plants per year is all but infeasible, in particular in light of decommissionning of older plants programmed in many present nuclear fleets. In Schneider M. & Froggatt A. 2004 « The World Nuclear Industry Status Report 2004", The Greens/Free Alliance Bruxelles december. (ANTOINE BONDUELLE, Université Lille II)	Accepted
4-1477	A	80	1	0	0	Table 4.4.2. Current solar thermal is neither current nor correct in the table. Industry figures for 26 countries by the end of 2001 is 41,795 GWh (150, 463 TJ/year) (in Renewable Energy World, review issue 2004-2005 p.218), that is 0,15 EJ/year and not 0,04 EJ/year. With an annual growth of 28%/year in the dominant market of China, this figure is likely to have doubled since. This is the figure quoted at page 53 of the chapter from Martinot et al (0,3 EJ). Please correct this figure. (ANTOINE BONDUELLE, Université Lille II)	Accepted – will be checked
4-1478	A	80	1	80	0	In the table, a very large interval is provided for the nuclear energy costs (10-100). The latter should be lowered according to the existing litterature (WNA, 2005, The new economics of nuclear power). It seems to me that an interval of 25-80 might be closer to the reality. (Jean-Yves CANEILL, EDF)	Accepted – will be checked
4-1479	A	80	1	0	0	In Table 4.4.2, it does not make sense to me to give the technical potential for	Accepted

						things like solar, wind, and biomass in terms of EJ (I can't even imagine what this would mean). It only makes sense to give the technical potential for renewable forms of energy as a flow (EJ/yr). Thus, use the flows from Table 4.3.1 (page 23) instead. (Danny Harvey, University of Toronto)	
4-1480	A	80	1	0	0	Table 4.4.2. See my comment on Figure 4.3.2 on page 32. (Jan Willem Storm van Leeuwen, Ceedata Consultants)	Noted
4-1481	A	80	1	0	0	Table 4,4,2 Wall St. J, 2006 not available in the reference paragraph; I suggest to use only scientific references, not newspaper (Stefano Caserini, Politecnico di Milano)	Accepted – will be checked
4-1482	A	80	1	0	0	Table 4,4,2 Wall St. J, 2006 not available in the reference chapter; I suggest to use only scientific references, not newspaper (Stefano Caserini, Politecnico di Milano)	Accepted – will be checked
4-1483	A	80	1	0	0	Table 4,4,2 Uses two different lines to consider nuclear technical potential with and without fuel recycle. The range is much larger that any other range, 70 times between min and max, so is too large. The upper limit of nuclear potential without fuel recycle could be interesting. 400,000 EJ to 2050 has to be better demonstrated. I would like to see more on this on the text. (Stefano Caserini, Politecnico di Milano)	Noted
4-1484	A	80	1	0	0	Table 4,4,2 the "7" near ">80.000" in the solar pv line is without references (Stefano Caserini, Politecnico di Milano)	Accepted
4-1485	A	80	1	80	1	The footnotes of the Table start from No. 4. The first three footnotes are missing. Footnotes 1 & 2 have never been mentioned in the Table while footnote 3 has been refereed but never explained. The question mark (?) also needs clarification. (Muhammad Latif, Applied Systems Analysis Group)	Accepted
4-1486	A	80	1	80	1	I do not agree with the energy cost 10-100/MWh for nuclear fuel. Nuclear Fuel cycle cost is inferior to 10$/MWh (see DGEMP 2003, OECD/NEA 1994 publication on fuel cycles costs). there is a mistake in the figure. (DELLERO Nicole, AREVA)	Accepted – will be checked
4-1487	A	80	1	80	1	I do not agree with the energy cost 10-100/MWh for nuclear fuel. Nuclear Fuel cycle cost is inferior to 10$/MWh (see DGEMP 2003, OECD/NEA 1994 publication on fuel cycles costs). there is a mistake in the figure. (DELLERO Nicole, AREVA)	Accepted – will be checked
4-1488	A	80	1	0	0	Table 4.4.3 suggests that the technical potential of oil could be up to 35,000 EJ out	Accepted – will be checked

						to 2050 (over 6000 trillion barrels, or three times the nearest view to a consensus there is, and over 50% higher than the US Geological Survey's 'High' estimate. This seems 'over the top'. (Michael Jefferson, World Renewable Energy Network & Congresses)	
4-126	B	80	1	80	0	Table 4.4.2. Generation USD/MWh—Need economic assumptions footnoted U.S. Government (Government of U.S. Department of State)	Noted
4-127	B	80	1	80	0	Table 4.4.2. The column "Energy costs in 2005" would be more useful if the units can be shown in consistent units. U.S. Government (Government of U.S. Department of State)	Rejected
4-128	B	80	1	80	0	On Table 4.4.2. footnotes 1-3 appear to be missing. Also, for natural gas the technical potential is marked with footnote 3, but footnote 6 is probably what is intended. Review all footnotes. U.S. Government (Government of U.S. Department of State)	Accepted – will be checked
4-129	B	80	1	80	0	It is not at all clear what is meant by "Technical Potential to 2050." In fact the information provided is misleading. For example, it is not technically credible that nuclear fission could produce 400,000 EJ of power by 2050, even with fuel reprocessing, due to the slow doubling time of fission breeders. It also contradicts the value presented in table 4.3.1. Similarly it is not technically credible that coal could produce 130,000 EJ by 2050, and this number contradicts 4.3.1 as well. U.S. Government (Government of U.S. Department of State)	Noted
4-130	B	80	1	80	1	Table 4.4.2 Cost data not consistent with table page 23. Some 2030 costs of renewable technologies are quoted higher than in table 4.3.1 for today. (Government of Germany)	Accepted – will be checked
4-1489	A	80	0	0	0	Table 4.4.2. I have several problems with this table including: 1) there are some inconsistencies in the cost data with Table 4.3.1; 2) the low end of the projected investment costs are way too low for natural gas, coal, nuclear, wind, geothermal, and biomass; 3) the project generation costs are low for natural gas, coal and nuclear as discussed above, 4) some of the notes in technical potential column for solar PV and biomass don't make sense. (Steve Clemmer, Union of Concerned Scientists)	Noted

Comments on section 4.4.3 +4.4.4 Bill

4-1490	A	81	0	88	0	Chapter 4.4, 2030 costs and potentials. The bulk of the conclusions in this chapter follow from one single model study and it is not clear to the reader what assumptions are used in the model, why the results are as they are, how the model results relate to the (sizable) renewable energy potentials mentioned elsewhere, and if that model reflects general scientific consensus. (Donald Pols, Friends of the Earth Netherlands/Milieudefensie)	Noted and modified
4-1491	A	81	1	81	34	If I understand the text on this page as well as the analyses that follows, it appears to me that the authors of this section consulted a very small number of general studies from the IEA, WEC, and ABARE, ect. and then plugged in assumptions about maximum penetration rates into a "Utrech model." Is that right? If yes, to my mind that is not a satisfactory fullfillment of the IPCC's mandate to review the technical literature. What is this model from Utrech? The reader is essentially presented with a black box that generates results without any understanding of this model's strengths and weaknesses and the peer reviewed literature that this model has helped to create. It might well be an excellent model but there is no way to tell that from what is here. More importantly, the authors should have assessed the technical literature for hydropower, the technical literature for geothermal, etc rather than relying on a handful of high level studies. To be sure, this would have been more work but Contributing Authors could have been brought on to help with the work. I find this entire section 4.4.3 very unsatisfactory for an archival piece of the technical literature like AR4. (James Dooley, Battelle)	Noted and clarified in text
4-1492	A	81	1	88	0	Chapter 4.4.3.1 – 4.4.3.6 page 81 – 88 All assumptions are based on wrong cost calculations and therefore should be changed after a solid cost analysis of renewable energy technologies, conventional energy sources as well as CCS has been undertaken. (Sven Teske, Greenpeace International)	Noted and will make clear
4-1493	A	81	1	0	0	General comment on section 4.4.3. This section is very hard to follow because of all the numbers. I also disagree with many of the cost assumptions, as discussed above, and what has been defined as maximum technical potential by 2030 for many of the options. I don't have the time to go through and critique every assumption I disagree with, but I will try to touch on some of the major issues below. (Steve Clemmer, Union of Concerned Scientists)	NEED REFERENCES
4-1494	A	81	1	87	0	Section 4.4.3: The cost ranges in tables are shown. However, some ranges are same	Reject as there is very little regional literature

						or very small among the regions (e.g., Coal CCS, Gas CCS). If you show the costs for divided regions, you should survey more literatures focusing on the regional differences in the costs. (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	
4-131	B	81	1	92	21	Sloppy reporting - An example is the untitled table on page 81 - where the reported emission factor estimates cannot be derived from the reported emissions and electricity supply, taken from the same rows. (Government of Australia)	Noted will make clear
4-1495	A	81	4	81	6	Check the numbers for GHG in GtCO2 for 1990 and 2005. (Wilhelm Kuckshinrichs, Forschungszentrum Juelich GmbH)	Acceot will correct
4-1496	A	81	5	0	0	There is something wrong with the numbers in this paragraph. It does not seem possible that 5.94 could grow to more that 25 in this time and even compound growth of 1.5% does not come anywhere near this. The numbers need checking. Potential emission reductions must have units of per year. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Accept will correct
4-1497	A	81	7	0	0	What is meant by the "unlikely probability of success"? Does it refer to the upper end of the range, or just any emissions reduction by 2010? It is currently unclear. (Michael Taylor, International Energy Agency)	Will clarify
4-1498	A	81	14	81	17	Is this ECOFYS model published? F534 find it in the references. I think it has many problems, but it is difficult to assess on the basis of the information presented here. The units are unclear and translating these into F534 contribution' do not even begin to add up numerically or imply a commensurate analysis. This whole section will serve to discredit this section of the report unless fundamentally reworked. (Steve Sawyer, Greenpeace International)	Will clarify and rewrite
4-1499	A	81	15	81	15	delete (developed by Ecofys Ltd., Utrecht, Netherlands): add in the references (Stefano Caserini, Politecnico di Milano)	Will clarify and rewrite
4-1500	A	81	15	0	0	In case the computer model developed by ECOFYS is mentioned in the report, it should be characterized in more detail to understand its structure and functionability. Otherwise, the model's results are less usefull for interpretation. (Wilhelm Kuckshinrichs, Forschungszentrum Juelich GmbH)	Will clarify and rewrite
4-132	B	81	15	81	15	Lack of transparency - It is not always clear that the analyses presented are based on a comprehensive review of the available literature, or on peer-reviewed literature. An example is the Ecofys model cited here, which does not appear to be	Will clarify and rewrite

						included in the chapter's Reference list. (Government of Australia)	
4-1501	A	81	17	81	20	This sentence references Figure 4.4.2 of IEA (2004a) - as far as I can tell there is no such figure. (Steve Sawyer, Greenpeace International)	Note and check
4-1502	A	81	22	81	23	the table presented here points out one of these major flaws, as the IEA Reference Scenario projects total electricity consumption 31,657 TWh/yr by 2030 (WEO 2004) p. 193 and in the technnical appendices at p. 431. By increasing this projected number to 40,380 (increasing by a third!), the entire analysis of the electricity sector is fundamentally flawed. These calculations are critical and will fundamentally affect the conclusions of this chapter as well as the part which makes it into the SPM. (Steve Sawyer, Greenpeace International)	Accept calculator error found
4-1503	A	81	22	81	25	This is not a table? If it is, to put it headed. (José Somoza, National Institute of Economic Research)	Accept
4-1504	A	81	23	0	0	2nd column – does this primary energy demand include industrial energy use? If so, then transportation is the only major sector left out, so why is the total only 256 EJ/yr when total energy use today is 490 EJ/yr according to page 7? Later (page 82, line 26) you say that the primary energy demand for electricity alone in 2030 would be 256 EJ, so there definitely seems to be some mistake in this table. (Danny Harvey, University of Toronto)	No just energy supply except for industrial CHP Will clarify
4-1505	A	81	24	81	28	"The maximum technical potential possible by 2030" is unclear. The estimation method for each technologies is unclear. If the method is complex, it is very research related works and will be out of the IPCC's work (only survey for the reviewed papers). Also see the comment to the definition in TS, p.16. (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Agreed will clarify
4-133	B	81	24	81	24	The term "maximum technical potential" is used here and nowhere else in this chapter, is this the same as "mitigation potential"? The term "mitigation potential" is often used, but never properly defined, if it is indeed the same as "maximum technical potential" this should be clearly stated, alternatively if it is meant as the amount of mitigation a technology can achieve given a certain carbon price, then that should be made clear. U.S. Government (Government of U.S. Department of State)	Noted will clarify
4-134	B	81	24	81	28	The analysis presented in section 4.4.3 looks at mitigation potential for a range of	Noted will clarify

						energy-supply technologies, but for each technology, the potential mitigation is unconstrained by what may be happening in the rest of the energy-supply sector. This is a serious limitation to the analysis, since as it is stated here, "...the potentials for each technology cannot be added using this method." Not only can the potentials not be added, but it is misleading to look at the potentials for any given technology, since those potentials would not be realizable under any policy that did not limit its focus to only that particular technology. EIA (2005). Annual Energy Outlook 2005 (http://www.eia.doe.gov/oiaf/archive/aeo05/index.html). EIA (2006). Annual Energy Outlook 2006 (http://www.eia.doe.gov/oaif/aeo). U.S. Government (Government of U.S. Department of State)	
4-135	B	81	24	81	28	"Specify model used and reference assumptions" Provide reference information. U.S. Government (Government of U.S. Department of State)	Noted will clarifiy
4-1506	A	81	27	81	28	This 'analysis' was conducted by whom and on what basis? (Steve Sawyer, Greenpeace International)	WIll clarify
4-1507	A	81	30	81	34	Where is the option for CHP? This option should have a large potential in the electricity sector (Government of European Community / European Commission)	DO WE HAVE SUFFICIENT DATA ON THIS FROM WADE?
4-1508	A	81	32	81	34	Suggest, "It is important to note that low-carbon energy source substitutions are unlikely unless they are cheaper or if policies, including carbon trading and a redirection of the 200+ billion USD/year in subsidies is redirected from fossil fuels, support their adoption." (Steve Sawyer, Greenpeace International)	AGREED THIS STATEMENT IS MADE SEVERAL TIMES
4-1509	A	81	32	0	0	CCS is in section 4.3.6. (Heleen de Coninck, Energy research Centre of the Netherlands)	ACCEPTED THANK YOU
4-136	B	81	35	81	0	"Need to add integrated outlooks/contribution by technology here vs. breakdown sections that follow." U.S. Government (Government of U.S. Department of State)	Unclear what is being asked for
4-1510	A	81	0	0	0	General comment on section 4.4.3. This section is very hard to follow because of all the numbers. I also disagree with many of the cost assumptions, as discussed above, and what has been defined as maximum technical potential by 2030 for many of the options. I don't have the time to go through and critique every assumption I disagree with, but I will try to touch on some of the major issues	Same as 4-1493

						below. (Steve Clemmer, Union of Concerned Scientists)	
4-1511	A	82	1	83	0	I miss CHP in this discussion. (Dolf Gielen, International Energy Agency)	WILL DISCUSS IF DATA ARE AVAILABLE
4-137	B	82	1	83	5	Confusion between BAU and mitigation parameters - It appears that some mitigation has been claimed from investment action already in the BAU projection, overestimating emissions avoided by mitigation. An example, is the untitled table on page 83, in relation to fuel switching. This table reports emissions avoided from investment in new gas capacity, which can be calculated at a rate of 0.67MtCO2e/TWh or 670g/KWh of new gas capacity whereas Table 4.4.3 on page 82 implies that the emissions avoided from investment in new gas over investment in new coal capacity at .306MtCO2e/TWh or 306g/KWh - this error apparently leading to an overestimate of over 100% of the emissions avoided for the sector. (Government of Australia)	NOTED will make consistent NEED TO REVIESW THIS DISCREPENCY
4-1512	A	82	9	82	12	Is Table 4.4.3 refering to Danish generation as earlier in the report the IEA figures are slightly different, eg 36% efficiency for coal instead of the 35 quoted here (John Kessels, Energy Research Centre of the Netherlands)	NOED will make consistent
4-1513	A	82	9	82	12	These calculations for the emissions from power generation are much more useful than those contained in tables 4.3.1 and 4.4.2 - and are relevant to the electricity sector. (Steve Sawyer, Greenpeace International)	Thank you
4-1514	A	82	13	82	23	Because conversion efficiencies vary due to a wide variety of factors it is always useful to state them, and why in this context the expression of the mitigation options in terms of gCO2/MJ are particularly useless. They should be expressed in gCO2/MWh. (Steve Sawyer, Greenpeace International)	NOTED will consider changing units
4-1515	A	82	13	82	23	This much fuel switching from coal to gas will have a major impact on natural gas prices and supplies that needs to be considered in this analysis for it to be credible. (Steve Clemmer, Union of Concerned Scientists)	Agreed will state this in text
4-1516	A	82	13	82	23	This much fuel switching from coal to gas will have a major impact on natural gas prices and supplies that needs to be considered in this analysis for it to be credible. (Steve Clemmer, Union of Concerned Scientists)	Repeat 4-1515
4-1517	A	82	13	82	15	you refer to the higher temperatures from burning gas as raising the efficiency of the plant. I'm willing to believe that the higher temperatures gas burns at do give	Reject this is correct

						you an efficiency gain, but surely the bulk of the gain from moving from a coal plant at 40% to a gas plant at over 50% is because the gas plant is combined cycle and the coal plant single cycle, and the current text places all the emphasis on the temperatures. (Richard Green, University of Birmingham)	
4-1518	A	82	15	0	0	It seems to me the >40% in brackets should probably be <40%. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Reject >40% is what is meant for the best coal plants
4-1519	A	82	20	0	0	The range of savings for CCGT and advanced steam cycles was estimated to be between 500 Mt CO2 and 1400 Mt CO2, and depends critically on a number of factors including timing and sequence of policy measures, as well as other factors. (Michael Taylor, International Energy Agency)	Agreed will so state in text
4-1520	A	82	30	86	29	References for the maximum shares are required. How does this refer to other studies that include all options in one integrated approach for instance. (Government of European Community / European Commission)	Unclear, but will check reference
4-138	B	82	30	87	13	Reliance on partial or sectoral analysis of emissions impacts of mitigation actions, neglecting the full emissions inventory impacts due to offsite-offsector emissions consequences leading, in some cases, to apparently overestimating estimates of mitigation potential. Examples would appear to include chapter 4, page 83 lines 8 and 23. (Government of Australia)	Noted, but unclear how to proceed Will check to be certain that this is correct
4-1521	A	82	31	83	5	The cost of fuel switching strongly depends on the price difference between coal and gas. The costs for switching from coal to gas in the table suggest a small difference only between coal and gas (in USD per GJ). THe low estimates of 9 USD per ton suggest gas cost which are approx. 20% above coal costs. This is an unusual price setting. Current gas price levels suggest costs of fuel switching above 60 EUR/ton (or 75 USD/ton). (Walter Ruijgrok, EnergieNed)	Noted will check figures for ccuracy
4-1522	A	82	31	82	31	Need to have consistency on the life of power plants, on page 66 line 18 around 40 years is mentioned, I suggest a range of 40-60 years at least for coal fired plants (John Kessels, Energy Research Centre of the Netherlands)	Will check to insure that a constant value is used probably 50 years
4-1523	A	83	3	0	0	Please add "IEA analysis suggests up to 50 GW stationary gas fired fuel cells by 2030, growing to 200-300 GW by 2050. This represents around 3% of all power generation capacity worldwide. This would generate about 0.5 Gt emissions reduction."Source: Prospects for Hydrogen and Fuel Cells, IEA/OECD, Paris, 2006, p. 173-175.	Will check references

						(Dolf Gielen, International Energy Agency)	
4-1524	A	83	4	87	13	The same as page 81, to put it headed (José Somoza, National Institute of Economic Research)	Agree
4-1525	A	83	6	0	0	Section 4.4.3.2. It depends what message this section is trying to send as to whether this is reasonable or not. Even the IEA Alternative Scenario was fairly conservative in its assessment of the expansion of nuclear power. It assumes, for example, that new nuclear plants will be built for the first time in a country only where the development of nuclear power remains a responsibility of the government and where that government is firmly committed to such projects. It also assumes that phase out in a number of European countries continues, albeit at a slower pace. If this section of the IPCC report is meant to be assessing what could be achieved, these are quite restrictive assumptions. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	Noted will comment in text
4-1526	A	83	6	82	18	Again EJ of energy produced by nuclear power is irrelevant. TWh/yr is the useful number. And given that the percentage of global electricity supply supplied by nuclear is projected to be 15%, and the exact same number is projected for hydro (p 84 line 16 (table)) why the avoided CO2 from nuclear is more than 250% higher (1.09 vs. 2.85)? Replacing 15% of the global electricity supply with low carbon sources would avoid the same quantity of GHG regardless of the technology used. This confusion of the primary energy and delivered service (in this case electricity) persists throughout this section. (Steve Sawyer, Greenpeace International)	Noted will revise
4-1527	A	83	6	0	0	Section 4.3.3.2: The figures here only compare emissions from electric power generation (p. 81, l. 13-14). However, as stated in the comment regarding p. 31, l. 35-38, “It is…not sufficient to simply compare GHG emissions from nuclear power with emissions from fossil fuel power plants. If combined heat and power is taken as the standard for comparison, it could be argued that the emissions from nuclear power should in fact be calculated by adding the emissions from fossil fuels used for heating to the emissions from nuclear power generation.” The estimates quoted here for CO2 avoided from switching to nuclear power are therefore much too high and the cost estimates are correspondingly low. (Kenichi Oshima, Ritsumeikan University)	Noted CHP is not the comparison
4-1528	A	83	8	83	9	"Since the nuclear plant and fuel system is not produced using large quantities of fossil fuels in the fuel cycle, net carbon emissions can be lowered significantly." This sentence would be somehow wrong. Net carbon emmisionfrom nuclear energy	Noted

						is low, principally because it did not use fossil resources as fuels in the GENERATION PROCESS. (Ryota OMORI, Japan Science and Technology Agency)	
4-139	B	83	8	83	8	Transparency - can the assumptions about nuclear power be verified/referenced? (Government of Australia)	ACCEPT WILL PRVIDE REFERENCES
4-1529	A	83	12	0	0	The range of savings is from 300 to 1300 Mt CO2 (Michael Taylor, International Energy Agency)	Accept will change
4-1530	A	83	13	0	0	When talking about the scenario adopted here, it is better to use the present tense. Thus, change "was" to "is". Similar comment applies to several instances of the past tense in the next few pages. (Danny Harvey, University of Toronto)	Reject Work is do0ne in the past
4-1531	A	83	16	85	20	The cost range (in USD per ton CO2) does not seem consistent between the various options, for instance nuclear and wind energy. As indicative price for nuclear, the text states USD 25-65 per MWh and for wind 30 - 100 USD/MWh. This would, logically, imply that the costs per ton of avoided CO2 are (slightly) lower for nuclear than for wind. However, according to the tables wind is cheaper -in CO2-terms- than nuclear in the lowest range: -11 versus -2 for OECD.The high end of the estimates for nuclear is, however, lower than would appear from the numbers for hydro and wind. Also remarkable to notice that hydro, wind, bioenergy and geothermal all share a similiar low end estimate for the electricity price: 30 USD per MWh. In that case, it would be logic to assume that the low end cost effectiveness in CO2 terms would be the same (since they all replace the same electricity in a particular region). However, these low end values vary a little. Some inconsistencies seem to exist in the data analysis or data representation. The last digit in the values for cost effectiveness suggest accuracy, which is, however, not realistic. It would be more appropriate to use rounded figures (e.g. 60, 75, 80). (Walter Ruijgrok, EnergieNed)	Agreed will round data
4-140	B	83	16	83	16	Point at risks of the nuclear strategy. (Government of Germany)	Reject This is discussed earlier
4-141	B	83	17	83	17	With new nuclear builds worldwide, the maximum contribution of nuclear power to the mix by 2030 can be expected to be much greater than the 15 percent shown. U.S. Government (Government of U.S. Department of State)	Reject The numbers are based upon a balance among numerous competing estimates
4-1532	A	83	22	83	25	There is a problem of lack of firm data. It has been estimated that wind turbines	Noted. No data

						recover CO2 emissions involved in their manufacture within 6 months of operation but that with 1,000 tonnes of cement being used in the foundations of modern turbines plus cement used for access roads, plus the international transportation of huge modern turbine masts, the actual period is far longer - some have estimated it as several years. But there is no proper independent evaluation that I am aware of. (Michael Jefferson, World Renewable Energy Network & Congresses)	
4-142	B	83	23	83	23	Transparency - can the assumptions about renewable power be verified/referenced? (Government of Australia)	Noted will supply information on all sources
4-1533	A	84	2	0	0	The mitigation potential of Biomass and geothermal is in the range of 100 to 300 Mt CO2 in 2030 and around 100 MtCO2 for Solar photovoltaics and concentrating solar power. For wind it is between 300 and 1000 Mt CO2 in the IEA Energy Technology Perspectives. (Michael Taylor, International Energy Agency)	Accept and will update
4-1534	A	84	2	0	0	The mitigation potential from hydro is 500 MtCO2 in the IEA Energy Technology Perspectives. (Michael Taylor, International Energy Agency)	Accept will note and update
4-1535	A	84	3	0	0	add concentrating solar power (Robert Pitz-Paal, German Aerospace Centre (DLR))	Reject not needed
4-1536	A	84	4	84	8	We believe that considerably higher levels of non-hydro renewables could be technically and economically deployed by 2030 than what is assumed in this analysis, particularly for solar and wind. The amounts included in the analysis should by no means be called "maximum potentials" (Steve Clemmer, Union of Concerned Scientists)	Reject no reference is provided
4-1537	A	84	4	84	8	We believe that considerably higher levels of non-hydro renewables could be technically and economically deployed by 2030 than what is assumed in this analysis, particularly for solar and wind. Research by the national renewable energy laboratory (NREL) has shown that it technically and economically feasible for wind to provide 20% or more of US electricity generation by 2020 or 2030. NREL has also done modeling showing solar can provide a much larger share of generation than assumed here with the appropriate policies. The amounts included in the analysis should by no means be called "maximum potentials" (Steve Clemmer, Union of Concerned Scientists)	Note will check NREL data
4-1538	A	84	10	87	15	What is the basis for the assertion that most bioenergy growth will be in the developing nations? Is there an assumptiuon that growing biomass is a cheaper way to reduce emissions for those countries and that they have plenty of land so	We wilol provide reference to Moreira and other authors

						that the biocrops will not crowd out food crops, if yes what's the reference for that assumption and how robust is it? Bioenergy would seem to have a bright future in the OECD as well. What is the basis for these estimates? Where do these numbers come from? Are they just guesses? Are they the result of detail bottom-up modeling taking national circumstances into account and differentitated growth rates in varuous countries? Where economics / costs factored in? This section seems very intelectually sloppy given that there are a number of energy and economic models that have been developed over decades specifically to get a handle on how various technologies compete against each other to meet a given energy demand and constraints on emissions. (James Dooley, Battelle)	
4-1539	A	84	10	87	15	What is the basis for a number of these assumptions about penetration rates of various energy technologies? This is a critical piece of information that is needed to judge the value the analysis presented here. For example, new hydro can displace 15% of new fossil power plants. Where did that number come from and did it take into account the significant issues associated with citing new hydro plants that were mentioned earlier? is it cost effective to push hydro deployment to this level? Likewise, wind can reach 5-10% of the "global supply mix by 2030" is that supposed to be 5-10% of electricity generation or total primary energy supply (the same term "energy mix" is used for geothermal energy, "energy mix" is not a technical term)? (James Dooley, Battelle)	Noted will provide explanation of source of estimates
4-1540	A	84	10	87	15	The section on NGCC+CCS even makes less sense. In a world of high natural gas prices and relatively stable coal prices NGCC+CCS plants will not dispatch unless carbon prices are extremely high. The economic choice would be to use IGCC+CCS for baseload applications and use natural gas plants that vent CO2 to serve peaking loads. There's no justification for an assumption like 20% of gas plants adopt CCS by 2030. See for example, Wise MA, JJ Dooley, RT Dahowski, and CL Davidson. "Modeling the impacts of climate policy on the deployment of carbon dioxide capture and geologic storage across electric power regions in the United States." Submitted to the International Journal of Greenhouse Gas Control. July 2006. (James Dooley, Battelle)	Noted will comment in text
4-1541	A	84	10	87	15	The CCS section cites a Dow Jones article as one of its major sources of information? Please make use of the IPCC Special Report on CCS. It is a far more	The IPCC Special Report is referenced throughout this chapter.

						robust analysis of the role that CCS technologies can play in the world than a Dow Jones newspaper article and a couple of new RIVM and ABARE studies. There is just no reason to ignore this comprehensive analysis that was recently published by the IPCC. Why would anyone assume that 30% of new coal plants will be equiped with CCS? What's the rationale behind that? Has someone modeled the "30% of all new coal plants must use CCS" policy and compared it to cases where a carbon tax is applied across the electricity sector or across the entire economy/ What's the justification for pulling a number like 30% for this analysis? Why not assume 28.9439% of all new plants adopt CCS? Why is only the Hendricks work on storage potentials used? Again, I simply cant understand why the Special Report on CCS isnt made better use of. (James Dooley, Battelle)	Will examone assumption about % CCS
4-1542	A	84	18	84	20	There's no technical or economic reason why wind should be restricted to 5-10%. Wind could reasonably achieve a penetration of 20% or more under a scenario that is looking at maximum potential. (Steve Clemmer, Union of Concerned Scientists)	Will state basis for value
4-1543	A	84	18	84	20	See preceding comment. There's no technical or economic reason why wind should be restricted to 5-10%. Wind could reasonably achieve a penetration of 20% or more under a scenario that is looking at maximum potential. (Steve Clemmer, Union of Concerned Scientists)	Will state basis for value
4-1544	A	84	18	84	20	It is possible to do MUCH more than this if we are prepared to oversize the wind farm and simply discard the excess electricity produced during the 5-10% of the time when the turbines can actually produce power at their rated capacity. If the transmission link is not oversized, then there is a savings in the transmission cost per kWh of delivered electricity that can partly or largely offset the cost penalty due to the fact that some of the potential wind energy output is discarded due to oversizing of the wind farm. This is a very important point – it illustrates that the potential for wind energy is much larger than generally thought possible. See Cavallo (1995) and Lew (1998), and my comments to page 41, lines 6 and 7. REFERENCES: Cavallo, A. 1995. “High-capacity factor wind energy systems,” Journal of Solar Energy Engineering 117, 137-143. Lew, D.J., R.H. Williams, X. Shaoxiong, and Z. Shihui. 1998. “Large-scale baseload wind power in China,” Natural Resources Forum 22:165-184.	Will compareer this information with the basis for our analysis

						(Danny Harvey, University of Toronto)	
4-143	B	84	19	84	0	"…an assumed maximum of 5-10%"...why limit vs. run economic model? What policy scenario and fuel prices were used?" U.S. Government (Government of U.S. Department of State)	Will state basis for value
4-1545	A	84	25	84	28	This table doesn't make any sense, esp, when compared to the hydro table above…if there will be an addition 1794 TWh/yr in 2030 from hydro on top of the ca. 2600 TWh/yr currently produced from hydro, that would give approximately 4400 TWh/yr which is indeed close to 15% of 31,000 Twh in the reference scenario, but only about 10% of the 40,000 Twh/yr which is supposedly being used as the baseline for this calculation. And then compared with the wind, if 2005 wind production was 124 TWh, and there will be an addtional 1770 by 2030 for a total of almost 1900, that is considerably less than 10% of either 31K or 40K TWh/yr. Our own projections show wind producing about 2750 Twh/yr under the 'moderate' growth scenario, and 5150 TWh/yr under the high growth scenario (GWEC/Greenpeace 2006)...which would put the percentage numbers in about the same ballpark. Who determined that the technical potential of wind was this lowball amount? (Steve Sawyer, Greenpeace International)	Will state basis for assumptions
4-1546	A	84	27	85	7	Recent studies suggest much higher shares of PV and CSP in the year 2030, i.e. from 8-15% of the demand, also with considerable contributions of CSP in OECD-countries, like the USA, Australia, Southern Europe. This would lead to a mitigation potential of at least 1 Gt CO2. References: a) F. Trieb et al.: Concentrating Solar Power for the Mediterranean Region, (MED-CSP). Study prepared for the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), March 2005. http://www.dlr.de/tt/MED-CSPF. b) Trieb et al.: Trans-Mediterranean Interconnection for Concentration Solar Power (TRANS-CSP), Study prepared for the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), April 2006. http://www.dlr.de/tt/trans-csp (Government of Germany)	Noted will exploreer whether this can be included
4-1547	A	84	28	85	6	you may want to distinguish: solar PV, solar thermal (low temperature) and concentrating solar power. By 2020 the cost of electricity of concentrating solar power is between US$0.35 and 0,62 /kWh as already stated in chapter 4.3.3.5. These are not "relative high costs" as stated in line 28 on page 84.! As mentioned earlier in the same chapter the potential for 2030 lies between 620 GW (2040) and	Good suggestion. We will try disaggregate

						4700 GW (2030) equivalent to 1200 to 10000 TWh/year equivalent to 0,6 - 5 GtC02 . CO2 avoidance cost in 2030 are estimated below 20 €/ton. (http://www.dlr.de/tt/institut/abteilungen/system/publications/Oekologisch_optimierter_Ausbau_Kurzfassung.pdf, figure 6) Therefore I would consider a larger CO2 mitigation potential realistic as given in the table specifically due to the potential of CSP. (Robert Pitz-Paal, German Aerospace Centre (DLR))	
4-1548	A	84	30	0	0	We disagree with the statement that solar "can theoretically gain a maximum 1-2% share fo the global electricity mix by 2030." Most solar projects will be installed on or near buildings that have a much higher economic value than is assumed in the analysis. When combined with potential cost reductions solar could theoretically achieve a much larger share. (Steve Clemmer, Union of Concerned Scientists)	Can you supply references?
4-1549	A	84	30	0	0	See comment above. We disagree with the statement that solar "can theoretically gain a maximum 1-2% share fo the global electricity mix by 2030." Most solar projects will be installed on or near buildings that have a much higher economic value than is assumed in the analysis. When combined with potential cost reductions solar could theoretically achieve a much larger share. (Steve Clemmer, Union of Concerned Scientists)	Can you supply references
4-144	B	85	1	0	0	Cost data for PV inconsistent (see also p 56) (Government of Germany)	Will check
4-145	B	85	5	85	18	Simple extrapolation to developing countries of costs analyses undertaken on developed economies. The table on direct Solar abatement costs, for example, gives a vast range of possible costs - from $3/t to$188/t for the OECD and wider ranges for developing countries. How has such an uncertain variable - ie vast cost range - which is clearly dependent on spatial characteristics of specific economies-been extrapolated to the wider world? (Government of Australia)	Noted will check
4-146	B	85	7	85	7	Additional solar electricity 0.34 TWH/a not plausible (Government of Germany)	Need data to respond
4-147	B	85	8	85	18	Simple extrapolation to developing countries of costs analyses undertaken on developed economies. An example relates to the use of bioenergy, which appears to be largely based on US studies. However, the price and cost implications of producing bioenergy in developing countries may well differ significantly from what may prevail in the US.	Agreed

						(Government of Australia)	
4-148	B	85	8	85	18	Reliance on partial or sectoral analysis of emissions impacts of mitigation actions. While it is noted in the text that bioenergy can require fossil energy for its production, it is not clear that the estimates of the emissions avoided by use of bioenergy accounts for the offsite-offsector emissions impacts of its production. If the emissions generated by the production of bioenergy are not taken into account, then estimates of emissions avoided are overestimated. (Government of Australia)	Accepted. There are good estinates of fossil fuel contribution for biofuels. We will make certain that this is included.
4-149	B	85	8	85	18	Reliance on partial economic analysis of mitigation, neglecting the full economic cost of mitigation due to offsite and offsector economic consequences. An example would appear to include chapter 4 page 85 line 8, bioenergy, as the reported cost ranges appear to apply to the direct cost to the generator rather than the full economy costs. In particular, it is not clear that the costs of converting and maintaining 10% of the world's arable land to bioenergy crops have been taken into account in this analysis. (Government of Australia)	No these costs have not been taken into account, but there is no literature to reference.
4-1550	A	85	10	85	10	references (Chapters 8, 9 and 10) is too generic: be specific. (Stefano Caserini, Politecnico di Milano)	Reject Data are included in the table.
4-1551	A	85	12	0	0	Insert “that” after “assumed” (Danny Harvey, University of Toronto)	Accept
4-1552	A	85	17	85	17	Line 17 ff --- the unnumbered table, third column. Is the “GtCO^2 /yr avoided” a net or gross estimate? That is, does the estimate take account of (subtracts) the large amount of CO^2-emitting energy needed to produce bioenergy? If it does, then it is “net”; otherwise it is “gross”. (Christopher Green, McGill University)	These destinaties are net, and this will be added to the table
4-150	B	85	17	85	17	Line 17 ff --- the unnumbered table, third column. Is the “GtCO^2 /yr avoided” a net or gross estimate? That is, does the estimate take account of (subtracts) the large amount of CO^2-emitting energy needed to produce bioenergy? If it does, then it is “net”; otherwise it is “gross”. U.S. Government (Government of U.S. Department of State)	These destinaties are net, and this will be added to the table
4-1553	A	85	20	85	25	should be 'additional 'geothermal energy by 2030' , not additional bioenergy… (Steve Sawyer, Greenpeace International)	Do not find this in the text
4-151	B	85	20	85	25	It would be useful for the authors to explain how geothermal power generation may result in C release.	Comes from carbonated geothermal reservoirs

						(Government of Australia)	
4-152	B	85	20	85	0	"…was assumed to provide a 4-5%"...One scenario, non-economic treatment. U.S. Government (Government of U.S. Department of State)	Basis will be made explicit
4-1554	A	86	0	87	15	In 4.4.3.4, CCS part is too long compared to other mature and commercialized technologies such as wind, hydro- and nuclear enengy etc. This part should be greatly simplified and shortened to balance with other technologies. Furthermore, it is not appropriate to overemphasize an immature technology in the IPCC report.CCS should be put at the end of this part. (Government of China Meteorological Administration)	CCS needs to be included, but we will reduceer the length of coverage in report
4-1555	A	86	2	86	5	Propability for CCS: the SRCCS, TC p42 states that CCS is unlikely to be deployed on a large scale in the absence of an explicit policy that substantially limits GHG emissions to the atmosphere. (Gabriela Von Goerne, Greenpeace)	Will repeat that here
4-1556	A	86	3	87	14	The CCS analysis makes no reference with regards to alternative technology dynamics.It does say that IEA scenarios imply enetring post 2015 , peaking after 2050 and being replaced by more advanced technologies thereafter. But it doesnt say how the latter could be crowded out. IEA (2004) has done modelling studies showing that at least PV and wind power deployment would be seriously delayed by CCS,but there is no mention of this problem in the special CCS report by IPCC nor in this chapter.On the other hand chapter three acknowledges the importance of induced technological change and the cumulative economic impact of early deployment of these energy technologies (or any other that would be affected by CCS deployment).There is one positive correlation attributed to Fisher (2006) which is not explained. (alberto pedace, Buenos Aires Univertsity)	Noted we will make a reference to this interaction with other options
4-1557	A	86	3	0	0	Section 4.3.3 ends without anythingon ocean/wave energy - is this intentional? (Michael Jefferson, World Renewable Energy Network & Congresses)	Will check to see if the potentiaal is large eenoog by 2030 to include
4-153	B	86	4	86	5	"Assessing the probability for CCS, as for fuel switching, is closely linked with the carbon price, which is very difficult to predict in 2030." The wording here is poor; how hard the analysts had to work is not the salient point. Why carbon prices are difficult to predict is more relevant. Reword text to read as: "The penetration of CCS technology by 2030 is highly uncertain, and depends upon both the carbon price and the rate of technological advances in CCS cost and performance." U.S. Government	Accept

						(Government of U.S. Department of State)	
4-1558	A	86	5	86	7	The distinction between CO2 eq. or CO2 only should be described fot the stabilization targets. (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Accept will make clear
4-1559	A	86	9	86	11	It makes much more sense from both an efficiency and economic standpoint to do CCS with IGCC instead of pulverized coal. (Steve Clemmer, Union of Concerned Scientists)	True but most present plants use pulverized coal
4-1560	A	86	9	86	11	It makes much more sense from both an efficiency and economic standpoint to do CCS with IGCC instead of pulverized coal. (Steve Clemmer, Union of Concerned Scientists)	SEE 4-1560
4-1561	A	86	9	0	0	"In this analysis … after 2015". This is a rather questionable assumption, and the reference doesn't seem to be peer-reviewed literature. It might also be considered to be contradicting the SRCCS results, which basically say that CCS deployment (post/precombustion and geological storage) could start once the incentive is high enough. (Heleen de Coninck, Energy research Centre of the Netherlands)	Accept will find beter reference
4-1562	A	86	10	0	0	The mitigation potential for CCS in 2030 is between 300 and 900 Mt CO2 at all coal-fired plants, not just pulverised coal plants. The total is likely to be in the middle of this range, given the need for commercial-scale demonstration before widespread deployment. (Michael Taylor, International Energy Agency)	Accept will clarify
4-1563	A	86	11	86	12	"Mitigation assessments … coal plants." 300 - 1000 MtC02 - are thos cumulative numbers or are they per year? What are the assumptions in terms of carbon price developments or other incentives? (Heleen de Coninck, Energy research Centre of the Netherlands)	These figures are per year
4-1564	A	86	14	86	16	The ABARE study must work with replacement rates. As in 2030 around 20% of all gas and coal-fired power plants are equipped with CCS, does that mean there is a date from which all power plants are using CCS? What is that date? Or is it more gradual? Something on the dynamics would be informative here. (Heleen de Coninck, Energy research Centre of the Netherlands)	Accept will add
4-154	B	86	14	86	18	Please update the quoted ABARE numbers to: "The ABARE (2006) study suggested 30,743 TWh of electricity demand by 2030 including 1811 TWh from coal with CCS, 7871 TWh from coal without, 1492 TWh from gas with CCS and	Will check newer ABARE study

						6315 TWh from gas without. The utilisation of CCS storage technologies reduced cumulative global emissions by about 4.4 Gt CO2 to 2030. Given the technology assumptions in their global technology + CCS scenario, cumulative global emissions to 2030 were reduced by about 21 Gt CO2, which is equivalent to a 7 per cent reduction in global cumulative emissions over that period, or a 17 per cent reduction in emissions at 2030, relative to their baseline scenario. (Government of Australia)	
4-1565	A	86	24	0	0	"reduces" should be "decreases" (Danny Harvey, University of Toronto)	Accept
4-1566	A	87	16	88	4	a 4% of biofuel share by 2030 is a conervative assumpion (Nikolaus Supersberger, Wuppertal Institute for Climate Environment Energy)	Need a reference
4-1567	A	87	17	87	17	"…beyond (section 4.3.4.3….". The reference to section 4.3.4.3 is not correct. (Government of India)	Reject this is the correct section
4-1568	A	87	18	0	0	The mitigation potential for biodiesel from oil crops and ethanol from grain/ starch is 100-300 Mt CO2 from each in 2030, around 600 MT CO2 for ethanol from sugacane, and around 200 to 400 Mt CO2 for biofuels from ligno-cellulosic feedstocks. The total mitigation potential is therefore between 1000 Mt CO2 and 1600 Mt CO2 in 2030. (Michael Taylor, International Energy Agency)	Accept will update references
4-1569	A	88	1	88	4	Figure 4.4.6. Is the story here that even with improvements in transport efficiency and the introduction of biofuels that the CO2 emissions from those developments is overwhelmed by the increase in the use of vehicles? If so I would suggest being more direct in saying that in the text as that is an important point for policymakers to understand. (James Dooley, Battelle)	Agreed will alter figure caption
4-1570	A	88	2	0	0	Figures 4.4.6 and 4.4.7 are very helpful in presenting a summary of the results, but the baseline numbers should be updated to reflect the latest IEA reference case (WEO 2006) and the savings potentials should match those in the end-use chapters (Peter Taylor, International Energy Agency)	Accept
4-1571	A	88	2	0	0	Figure 4.4.6 - This is a confusing diagram, and hard to determine what it is actually trying to say. Suggest either a complete re-draw or at the least a scale provided on the 2030 side to help deciphering the chart. Would prefer a re-think about how to present the information! (Christine Copley, World Coal Institute)	Accept and clarify

4-1572	A	88	2	0	0	Figure 4.4.6 needs to be updated to take into account of the correct mitigation potential ranges provided here. The vehicle efficiency range should also be checked with the ETP publication. (Michael Taylor, International Energy Agency)	Accept will check
4-1573	A	88	2	88	2	Figure 4.4.6 why is this figure included? There is no important reference to it in the text. (Government of European Community / European Commission)	Accept moving to transportkation Ch.5
4-1574	A	88	10	0	0	I cannot find the cited numbers in Chapter 6 (Section 6.5 is where they would belong). Chapter 6 does not cite IEA (2006), but I will see about adding it (so check back with Chapter 6). The stated reductions pertain to what year, and are relative to what baseline? (Danny Harvey, University of Toronto)	Need to coordinate with Ch. 6 thank you for pointing tbhis out
4-1575	A	88	10	0	0	The mitigation figures from this IEA report are the result of modelling analysis, not an assumption, although clearly they are built on underlying assumptions. (Michael Taylor, International Energy Agency)	Accept
4-1576	A	88	14	0	0	The mitigation figures from this IEA report are the result of modelling analysis, not an assumption, although clearly they are built on underlying assumptions. (Michael Taylor, International Energy Agency)	Accept repeat
4-1577	A	88	15	0	0	Materials product efficiency is between 50 and 100 Mt CO2 in 2030, while feedstock substitution is 100 to 300 Mt CO2. (Michael Taylor, International Energy Agency)	Accept will update
4-1578	A	88	19	88	19	The title of the section should written for clarity Electrical energy-supply … (Government of France)	Accept
4-1579	A	89	0	89	0	Table 4.4.4. Nearly 75% of the adoption of coal+CCS systems and 60% of gas+CCS between today and 2030 is going to take place outside of the OECD. Why? What's the assumed global climate policy that makes non OECD nations adopt such aggressive mitigation measures in the near-term? This table and the entire Section 4.4.3 is just not a very good assessment of the technical literature. Or to be more precise, this work in AR4 is so completely non-transparent that it is impossible to assess the quality of the work. For what it is worth, the IPCC Special Report on CCS's assessment of the technical literature revealed that most of the early deployment of CCS systems would be within the OECD with the rest of the world becoming ever larger adopters of CCS technologies in the second half of the century. (James Dooley, Battelle)	Accept We will make assumptieons transparent

4-1580	A	89	0	89	0	Geological CO2 storage has NOT reached the commercial stage. Storing CO2 needs subsidies or high taxes as in the case of the Norway Sleipner Field. Without high CO2 taxes no CO2 would be recovered and stored. (Gabriela Von Goerne, Greenpeace)	Noted There are commercial efforts underway with subsidies and policies
4-1581	A	89	0	89	0	Table 4.4.4. With the presented large amounts of bioenergy utilisation, also quite expensive production chains and technologies will probably be used. Also transportation costs will grow substantially. Is the 40% potential in the range 20-50 USD thus realistic? (Government of Finland)	Noted will explore
4-1582	A	89	1	0	0	Table 4.4.4: cost of fuel switching is probably underestimated and should be placed in one or two categories higher (20-50 and 50-100 USD/ton). Fuel switch below 20 USD per ton would imply a relatively small price gap between coal and gas. (Walter Ruijgrok, EnergieNed)	Noted other fuel switches are possible as well
4-1583	A	89	1	0	0	Table 4.4.4 Please incorporate the consequences of my comment on ch4, p. 84 line 28 to page 85 line 6. in table 4.4.4. Option 5 "solar". CO2 avoidance costs in 2030 for CSP are below 20€/ton (Robert Pitz-Paal, German Aerospace Centre (DLR))	Noted will check
4-1584	A	89	1	0	0	Table 4.4.4 Based on false costs analysis this table has no valid information, as all cost class ranges are in the wrong place. (Sven Teske, Greenpeace International)	Reject no alternative data given
4-1585	A	89	1	89	1	Table 4.4.4: Make clear that this table refers only to electricity supply and not to heat! Delete the word "heat" from line 3 of the caption! (,)	Noted Will clarify
4-1586	A	89	1	89	1	Table 4.4.4 Recent studies suggest much higher shares of PV and CSP in the year 2030, i.e. from 8-15% of the demand, also with considerable contributions of CSP in OECD-countries, like the USA, Australia, Southern Europe. This would lead to a mitigation potential of at least 1 Gt CO2. References: a) F. Trieb et al.: Concentrating Solar Power for the Mediterranean Region, (MED-CSP). Study prepared for the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), March 2005. http://www.dlr.de/tt/MED-CSPF. b) Trieb et al.: Trans-Mediterranean Interconnection for Concentration Solar Power (TRANS-CSP), Study prepared for the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), April 2006. http://www.dlr.de/tt/trans-csp (,)	Noted will check sources

4-1587	A	89	1	89	1	Table 4.4.4 is a mystery. The explanation of the black box into which the (admittedly highly flawed) conclusions of the previous section to come out with these numbers is woefully inadequate. (Steve Sawyer, Greenpeace International)	Noted will make transparent
4-1588	A	89	1	0	0	table 4.4.4 Table confusing--what does % refer to? (Joanna Lewis, Pew Center on Global Climate Change)	Noted will clarify
4-1589	A	89	1	90	43	Where do these assumptions come from and how do these relate to previous section? Please explain better, maybe use a graph or a scheme (Government of European Community / European Commission)	Noted will make clear
4-1590	A	89	11	0	0	Table 4.4.4 Based on my comments above I do not agree that this information represents "Potential maximum energy-source greenhouse gas emissions avoided" and I don't think the cost curves are accurate. (Steve Clemmer, Union of Concerned Scientists)	Noted will clarify
4-1591	A	89	20	0	0	Table 4.4.4 should be updated to reflect WEO 2006 reference case (Peter Taylor, International Energy Agency)	Noted will update
4-1592	A	89	0	0	0	Table 4.4.4 Based on my comments above I do not agree that this information represents "Potential maximum energy-source greenhouse gas emissions avoided" and I don't think the cost curves are accurate. (Steve Clemmer, Union of Concerned Scientists)	Noted do you have alternative references?
4-1593	A	90	3	90	3	…perceived 'maximum' potential'…??? As estimated by whom? This should be technical potential, or market potential with the assumptions clearly stated. These numbers will be unacceptable to anyone who knows anything about it and will be a discredit to the IPCC. (Steve Sawyer, Greenpeace International)	Noted will make clear assumptions
4-1594	A	90	5	90	6	As pointed out above, 40,380 is the wrong number…it should be 31, 657 (Steve Sawyer, Greenpeace International)	Accept will change
4-155	B	90	19	91	34	This overall methodology lacks any reference and feels a little too ad hoc. Instead of using this ad hoc methodology for combining the various technology specific mitigation potential analyses, it would be perferable to have a model with a consistent framework for analyzing the technologies in a market setting. Examples include: McFarland, J. R.; Reilly, J. M.; Herzog, H. J. (2004). "Representing Energy Technologies in Top-Down Economic Models Using Bottom-Up Information" Energy Economics 26 (4): 685-707	Noted will make clear

						Sands, R.D (2004). "Dynamics of Carbon Abatement in the Second Generation Model." Energy Economics 26 (4): 721-738. U.S. Government (Government of U.S. Department of State)	
4-1595	A	90	22	91	34	By comparing bullet point 4 (coal with CCS, p90) and point 8 (renewables, p91) a number of missbalances show up: 1) environmental issues are just mentioned negatively for renewables but are excluded for coal with CCS (environmental impacts due to coal mining and storage (see SRCCS)), 2. continued relativley high costs assumes that the cost of renewables remain too high. By comparing the given USD numbers it shows that the costs for coal with CCS are even higher (USD50) against USD<20 and 20-50 – renewables having even a higher mitigation potential of 1.04 against 0.9 for coal and CCS. Renewables are therefore not more expensive as CCS – is is CCS what is more expensive! The SRCCS, TS p44 correctly says for the future outlook of CCS that CCS will be competitive with mitigation options such as renewable energies. - It is important to balance all energy forms used!!! In general I see a missbalance between the valuation of fossil fuels like coal and renewable energies in the whole chapter. (Gabriela Von Goerne, Greenpeace)	Accept will comment on this
4-156	B	90	22	90	27	Does this allow for early retirement? Under a stringent carbon policy, coal plants will likely be retired far earlier than the assumption of a 50-year lifetime would suggest. If this methodology is designed to assess "mitigation potential", then the potentail certainly exists for a much faster replacement of existing fossil fuel generating capacity. U.S. Government (Government of U.S. Department of State)	No it does not assumes naturel rate of capital stock turn over
4-1596	A	90	24	90	34	Many instances here of where past tense should be changed to the present tense. (Danny Harvey, University of Toronto)	Reject will keep past tense
4-157	B	90	31	90	33	Here the described methodology assumes that after 2010, substitution of fossil fuels by renewables, nuclear or CCS is at a sufficiently large scale to stabilize GHG emissions from the energy-supply sector. This assumption does not seem to be in line with the goal of assessing "mitigation potential". A very stringent carbon policy with sufficient flexability may very well reduce emissions from the energy-supply sector, thus the assumption here appears to result in mitigation not reaching its full potential. U.S. Government (Government of U.S. Department of State)	Noted will clarify
4-1597	A	90	34	0	0	I'm a little surprised to see roughly the same percentage of CCS applied for gas and coal-fired plants (although It does depend on the total build of each) as CCS with	Noted will check

						gas-fired plant will be much more expensive than for coal. (Michael Taylor, International Energy Agency)	
4-158	B	91	5	0	0	Fuel recycling plants before 2030: a very critical assumption! (Government of Germany)	Agreed Will add caveat
4-1598	A	91	8	91	12	The so called constraints are not a matter of fact. Intermittency can be easily compensated by modern, optimised energy supply systems even for a share of 40% of renewables. Environmental issues are far lower than for all other options – this is not a constraint, but an advantage. “Continued relatively high costs” are even contradicted by this report itself. (,)	Noted will check
4-159	B	91	8	91	13	Inorder to achieve 20% displacement by renewables, the energy storage issue must be resolved. U.S. Government (Government of U.S. Department of State)	Noted storage will help, but not essential
4-160	B	91	10	91	0	Clarify whether this is current generation or future generation. U.S. Government (Government of U.S. Department of State)	Future generator will clarify
4-161	B	91	10	0	0	This constraint of maximum 20 % renewables by 2030 is arbitrary. These model calculations are not useful: output = input (Government of Germany)	Agreed will clarify the methodology
4-1599	A	91	23	91	30	We agree that even building an average of 30 nuclear plants per year would be (extremely) challenging (and unrealistic) given major concerns over security/terrorist threats, waste disposal, proliferation, and safety. (Steve Clemmer, Union of Concerned Scientists)	Noted
4-1600	A	91	23	91	30	We agree that even building an average of 30 nuclear plants per year would be (extremely) challenging (and unrealistic) given major concerns over security/terrorist threats, waste disposal, proliferation, and safety. (Steve Clemmer, Union of Concerned Scientists)	Noted repeat
4-1601	A	91	23	91	30	C 4, 91, 23, 91, 30 This method misses to account for external costs related to risks of accidents, final storage of the huge masses of waste produced in this scenario, proliferation and misuse. (Government of Germany)	Correct will state this in the text
4-1602	A	91	25	0	0	The rate of build that is possible is clearly a matter for educated guesswork. History shows us that the rate of build on nuclear power plants was ramping up quite quickly in the 60’s, 70’s and 80’s, reaching a peak of over 30 plants a year, before falling quickly again. This would suggest that, if nuclear was seen as one of	Noted but no references

						the key technologies for resolution of the world's energy issues and was strongly supported by governments and by industry, 30 plants per year could easily be constructed. Indeed, the technology is more widespread and there are more nations with the capability of building such plants now. Had it continued to ramp up at the old rate, 100 plants a year or more does not seem totally out of the question. (Stanley Gordelier, Nuclear Energy Agency of the OECD)	
4-162	B	91	28	0	0	30 nuclear power plants per year are highly unlikely. (Government of Germany)	Noted we will point out range in text
4-1603	A	91	31	91	34	While not wanting to contest the results or input data used, the share of CCS (vs renewables) is markedly different from the expectations in IEA (2006: Energy technology perspectives, scenarios & strategies to 2050), where a much larger share of CCS in the reduction potential is foreseen. This (apparent) difference should shortly be addresses and clarified. (Government of Belgium)	Noted We will make consistent
4-1604	A	91	36	91	46	This part seems important--could its fiding be included in the introduction/summary at the beginning of the chapter? (Joanna Lewis, Pew Center on Global Climate Change)	Accept will include
4-163	B	91	36	91	37	"Key conclusion" should this be highlighted somewhere. U.S. Government (Government of U.S. Department of State)	Accept will place in Executive summary
4-1605	A	91	42	0	0	Change "equates with" to "from electricity generation exceeds" (Danny Harvey, University of Toronto)	Accept will make change in text
4-1606	A	91	43	91	44	We strongly disagree that public acceptance of nuclear power has improved since the TAR was published, particularly following 9-11 (Steve Clemmer, Union of Concerned Scientists)	Noted we need to supply a reference
4-1607	A	91	43	91	44	We strongly disagree that public acceptance of nuclear power has improved since the TAR was published, particularly following 9-11 (Steve Clemmer, Union of Concerned Scientists)	Repeat
4-164	B	91	44	0	0	Where is the evidence for improved public acceptance? (Government of Germany)	Accept Need a reference
4-1608	A	92	1	92	21	Table 4.4.5 and Figure 4.4.7. I cannot see how these match up. The figure shows a significant possible contribution from CCS, the table shows this is very small and the text seems to say the same (but is not very clear). Maximum renewables is about right if renewable in the table is added to bioenergy. Nuclear power seems under represented in the figure compared to the table. Also, the Figure number in	Noted Will assure that these are consistent

						the text seems to be incorrect; should it be figure 4.4.6? (Stanley Gordelier, Nuclear Energy Agency of the OECD)	
4-165	B	92	1	92	5	Table 4.4.5: The OECD is not a region - suggest changing the explanation by deleting "major world region" to "major global groupings". (Government of Australia)	Accept
4-1609	A	92	8	92	8	Presumably you mean figure 4.4.7, since 4.4.6 is about oil and transport (Steve Sawyer, Greenpeace International)	Accept will change
4-166	B	92	8	92	8	The text here refers to Figure 4.4.6, this was probably meant to be Figure 4.4.7 which appears on this page and is not referred to anywhere in the text. U.S. Government (Government of U.S. Department of State)	Accept will change
4-1610	A	92	15	92	21	Re Figure 4.4.7, the underlying figures are so untransparent and unclear and confused as outlined above, I don't trust it. However, assuming this gets clarified/fixed, suggest that the units on the left should be TWhr produced, and the quantities of the difference supply numbers expressed as a percentage...the CO2 emissions of the remaining themral power plants could then be quantified on the right hand side...and show them going down (in the left chart) or up (in the right chart). (Steve Sawyer, Greenpeace International)	Noted will explore
4-1611	A	92	15	92	16	Figure 4.4.7. What determines the high and the low range? What is the relation with the previous calculations where only one moment in time was used, there seems to be little relation. Please make a bar chart based on the data of the previous section and delete this figure (Government of European Community / European Commission)	Noted will address
4-1612	A	92	18	0	0	This is a nice figure, but I would use a much larger font in the labels. (Danny Harvey, University of Toronto)	Accept will change
4-1613	A	92	18	0	0	Figure 4.4.7 -Again confusing diagrams and would benefit from an alternative representation of the data. The figure text says "indicative low and high" but it would appear the graphs are place 'high' then 'low'. This also confusing. (Christine Copley, World Coal Institute)	Accept will change
4-1614	A	92	18	0	0	Figure 4.4.7 is supposedly based on IEA 2006a, as of you references. Could you please provide the data used to caluclate these graphs and the source pages or sections within the book, some of the data doesn't look quite right. We need to check this graph for you.	Noted will improve figure

						(Michael Taylor, International Energy Agency)	
4-167	B	92	18	92	0	Figure 4.4.7. How does the mitigation potential here relate to the mitigation potential resulting from the methodology described in this section? U.S. Government (Government of U.S. Department of State)	Should be the same will check to be sure that is the case.

Comments on section 4.5, 4.6, Joergen + Hans

4-1615	A	93	1	106	5	I am surprised that there is no analysis or description of the the EU emissions trading scheme in this section. There have been a number of impacts on the power sector including the issue of "windfall" profits. There is also no mention of the impacts of the CDM and the projects within the energy sector that have resulted from this mechanism. (Nick Campbell, ARKEMA SA)	Accepted: EU-ETS & CDM should be mentioned in section 4.5
4-1616	A	93	1	93	1	Change polices into policies (Government of France)	Accepted
4-198	B	93	1	109	0	Policies must be effective in both the near-term and long-term. Emission Reduction Policies would work best in a long-term century long scenario for reducing emissions and would not work well in a thirty year scenario. U.S. Government (Government of U.S. Department of State)	Noted
4-1617	A	93	8	0	0	"A variety of government research and policies"? Government research, for example? (Heleen de Coninck, Energy research Centre of the Netherlands)	Rejected, detailed in section 4.6
4-1618	A	93	18	93	19	Technically, governments also are quite involved in early deployment policies and programs. (Kelly Sims Gallagher, John F. Kennedy School of Government, Harvard University)	Accepted R D&D changed to RDD&D.
4-1619	A	94	0	94	0	Table 4.5.1. last row mentions under CCS development „deep ocean sequestration". It is important to mention that this technology is ruled out from many countries including the EU as a mitigation option because of possibly large environmental impacts. Even the SRCCS states that a better understanding of impacts is required and storage has not been demonstrated at a signifant scale for a long time (see SRCCS, TS, p66): delete „deep ocean sequestration2 in the table, it is missleading. (Gabriela Von Goerne, Greenpeace)	Accepted: "deep ocean sequestration" changed to "Underground geological formations"

4-1620	A	94	0	0	0	Table 4.5.1: i) The table heading is misleading and must be rephrased. It refers to options to reduce energy demand and hence GHG emissions while it includes CCS as one option. CCS leads to decreased energy efficiency while reducing emissions. Similarly, it cannot be generally claimed that renewable energy options reduces energy demand. For example in most cases biomass-based power generation is less efficient than natural gas-based. ii) The table is not a complete list but merely provides examples. (Government of Sweden)	Accepted: “energy demand and hence” deleted in table heading.
4-1621	A	94	0	94	5	Table SPM 4.5.1: It's not clear whether you're actually looking at all demand-side policies to bring about energy efficiency, even though you say so in the table heading. For example, you omit real-time electricity metering, yet causes load-shifting, which generally leads to more efficient generation. (Government of Environment Canada)	Noted: see 4-1620.
4-1622	A	94	1	0	0	Table 4.5.1: I don't see that 'deep ocean sequestration' fits under 'General policy objectives and options' in light of that what governments say. Please skip it. (Manfred Treber, Germanwatch)	Noted: see 4-1619.
4-1623	A	94	1	0	0	Table 4.5.1 This table can be very usefull, but it is very unfortuntate in the column of "Technological development and diffusion". The second cell violates is wrong as there are no "clean hydrogen sources" other than those coming from a primary clean energy source (renewable). When it comes to CCS, the choice of keywords could not be worst: it is true that "Deep ocean sequestration" and "Chemical sequestration" come out very weak and undesirable options after rigurous analysis in the IPCC SRCCS (2005) but this does not mean we want technological development in these directions¡¡¡¡ . "Biological sequestration" has nothing to do with CCS. I would suggest for the CCS box the two bullets : "Demostrate capture and storage at large scale. R&D to reduce capture cost". (JUAN CARLOS ABANADES, INCAR-CSIC)	Accepted: “clean hydrogen sources” changed to “hydrogen as a newenergy carrier”. Concerning “deep ocean sequestration” se 4-1619.
4-1624	A	94	1	0	0	Table 4.5.1. The "deep ocean sequestration option" is particularly controversial and has been put forward by no government as a policy objective. This mention deepens the possible controversies among scientists and governments regarding capture and storage. It should be removed. Maybe a "underground storage" should fit better. (ANTOINE BONDUELLE, Université Lille II)	Accepted: se 4-1619
4-1625	A	94	1	0	0	Table 4.5.1: The caption says that the options in the table reduce energy demand, but also CCS and renewables are mentioned. Those options don't reduce energy	Noted: see 4-1620.

						demand. In general, the table is confusing in many respects. What are, for instance, "emission charges"? That is not a term commonly used, in my experience. The columns are not consistent with the bullets in 4.5.1, which intuitively they should be. Also, it is not complete. Voluntary agreements to install CCS is also possible, as well as quota obligations. I don't understand the cell with "chemical and biological sequestration" in it - what is a tecchnology doing there? It seems to me that this table doesn't work in its current form, hopefully it can be improved. (Heleen de Coninck, Energy research Centre of the Netherlands)	Voluntary agreements to install CCS should be included.
4-1626	A	94	1	0	0	Table 4.5.1. With regard to the technological development and diffusion of carbon capture and storage, providing further information about geological sequestration is recommended. (Government of Japan)	Noted: see 4-1619.
4-168	B	94	1	94	5	Table 4.5.1: Row CCS - the authors should consider whether it is appropriate to include "Deep ocean sequestration" in the technological development and diffusion column, due to the significantly immature state of the technology and the currently limited understanding of the biological impacts of deep ocean storage. (Government of Australia)	Noted: see 4-1619.
4-169	B	94	1	94	0	Table 4.5.1. Many of the "policies" listed in this table are misplaced or not actually policies. For example, "cleaner power generation from fossil fuels" is listed under the "Technological development and diffusion" policy option with the policy objective of "Energy efficiency." There are several problems here: first, "cleaner power generation from fossil fuels" appears to be an objective not a policy, a policy may be an R&D subsidy for technologies that allow "cleaner power generation from fossil fuels"; secondly, "cleaner power generation from fossil fuels" likely will not result in the supposed policy objective of incresaed "energy efficiency," many of the technologies that result in cleaner power actually decreased efficiency. U.S. Government (Government of U.S. Department of State)	Noted: see 4-1620
4-170	B	94	1	94	0	Table 4.5.1. Is there really any difference between "emissions charges" and "CO2 and CH4 taxes"? If there is, then "CO2 taxes" are a viable policy option for all of the listed policy objectives, not just energy source switching and renwable energy. U.S. Government (Government of U.S. Department of State)	Accepted: "emissions charges" and "CO2 and CH4 taxes" combined into “GHG taxes”.
4-171	B	94	1	94	0	Table 4.5.1 Add Supportive Transmission Tariffs and Transmission Access in the appropriate blocks of the matrix. U.S. Government	Accepted: “Supportive Transmission Tariffs and Transmission Access” included in

						(Government of U.S. Department of State)	Renewable/Regulatory cell
4-172	B	94	1	94	0	Table 4.5.1 Add Government-Supported Sinks in the appropriate blocks of the matrix. U.S. Government (Government of U.S. Department of State)	Noted: Sinks are treated in ch.8 & ch.9.
4-173	B	94	1	0	0	Table 4.5.1: figure caption is not logical. Write instead: "Policy objectives and options used to reduce greenhouse gas emissions from the energy supply sector" (explaination: energy source switching/renewables does not reduce energy demand; CCS even increases it) (Government of Germany)	Accepted: text changed.
4-1627	A	94	11	94	11	Ref my comment to Chapter 1, line 17, on the need for consistency in approach to energy security and high oil price matters. This sentence needs balanced by noting the impact on oil importing developing countries in particular of paying for high oil prices - in the Ch1 comment I provide references from IEA and ESMAP (World Bank) indicating the extent of that impact. The approach in Chapter 3 (page 96) in terms of the 'strong alignment' between responding to energy security and climate change, is a useful approach. Noting that at present oil exporting countries are profiting, and that its highly unlikely that climate change policies will have any impact in the real world on the oil price in the medium term, contrast to other factors at play at present (although climate-related impacts such as powerful hurricanes in the Gulf of Mexico, impacted oil price in 2005, according to analysts). (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	Accepted: line changed to “of fossil fuels and the impact on oil importing developing countries”
4-1628	A	94	13	0	0	Chapter 4.5.1.1 This chapter partly misrepresents the actual experiences with different renewable energy policies. Feed-in tariffs are put on the same level as tradeable certificates. In fact, green certificates are proven to be far less effective than feed-in laws. Renewable energy sources should get power purchase contracts like conventional power plants with a long term guaranteed price. Neither nuclear, nor coal power plants could be financed via short term, unreliable certificate prices. (Sven Teske, Greenpeace International)	Accepted: Text must be improved (see TS p43 line 2-3)
4-1629	A	94	13	94	15	It may be useful to add a sentence here differentiating between policies designed to 'transform' the energy sector towards lower and zero carbon sources, and those designed to give effect to more immediate ghg reductions. Renewable energy policies do the former, emissions trading, such as the European Emissions Trading Scheme do the latter, although intended to influence investments longer term. Additionally, given the importance of the EU ETS for the power sector, the section	Accepted: Text to be modified.

						on tradable permits (page 96) needs to at least reference the chapter where this is dealt with in greater detail. (,)	
4-1630	A	94	13	97	4	Section 4.5.1.1 Emission reduction policies for energy supply: May be we can comment the implicit possibilities in the implementancion of the Clean Development Mecanism (CDM), and, on the other hand, the activation of the aim for the development and the technological transfer, in the modernization of the energy systems of the developing and in the contribution of these to the mitigation of the GHG emissions coming from the energy sector. (José Somoza, National Institute of Economic Research)	Accepted: text on CDM will be added.
4-174	B	94	13	97	2	Section 4.5.1.1. Emissions reduction policies for energy supply. There is no mention here of a carbon price policy. The only mention of price-based instruments is in the discussion of feed-in tariffs as a policy for encouraging green power. Since the section is supposedly covering policies for reducing emissions in the energy supply sector, it seems absurd not to mention a carbon price. Furthermore, if price and quantity instruments for encouraging green power are going to be compared for in the "Feed-in tariffs/Quota obligations" section why is there no mention of the extensive literature comparing price and quantity instruments for greenhouse gas emissions reductions? Some references include: Weitzman, Martin L. 1974. Prices versus Quantities. Review of Economic Studies 41(4): 477–491. Pizer, W. 1999. Optimal choice of policy instrument and stringency under uncertainty: the case of climate change. Resource and Energy Economics 21: 255–87. U.S. Government (Government of U.S. Department of State)	Noted: “In Feed-in tariffs/Quota obligations section” carbon price/trading” will be mentione and references included.
4-1631	A	94	15	95	13	I find this section very policy relevant. It requires expansion and a proper debate among the author team. The message from section 4.7 "Concluding Statement" of the Chapter is clear (page110: renewable technologies would be competitive "if it were not for goverment support...for fossil fuels" ¡¡ . Subsidies on fossil energy are quantifyed in page 94, line 18 at "USD250-300 billion/yr". When I divide this number by the final energy consumption in the world (Table 4.2.1) I get about 1 USD /GJ ¡¡¡ of subsidy on fossil fuels, which is truly a huge number, considering that this is an average subsidiy all over the world ¡¡ and is in the order of magnitude of prices for coal in many parts of the world. However, when I look at the single reference used to support these numbers (De Moor, 2001; do the other	Noted.

						references in the same paragraph support this number?) I discover that Iran and Venezuela are subsidizing their oil use ¡¡¡ (but in this case, subsidy only means that their citizens get cheaper oil that at international prices). But then, I find it impossible to accept the notion that in Venezuela or Iran "renewable technologies would be competitive if it were not for goverment support...for fossil fuels", in this case oil. The same applies to coal in China or Australia. In summary and back to the key point: do the Lead Authors of the Energy Chapter of the IPCC AR believe that Goverment subsidies are a significant cause of fossil fuel dominance in the energy supply in the world today?. If those subsidies were removed, or had not existed, would we have a truly different energy supply mix today ?. Whatever the answer is for both questions, they need to be clear in htis section and move up to the executive summary and the SPM and TS. If the answer is yes (as it is now in section 4.7 and in the executive summary), I reccomend they expand in the report the justification of such a bold statement and figures. If the answer is no, they must delete this sentece from the executive summary and the similar text in the SPM and TS and disregard the single reference used (peer reviewed?) to suppport the above critical data. (JUAN CARLOS ABANADES, INCAR-CSIC)	
4-1632	A	94	18	0	0	Subsidies to renewable energy are now higher than 2-3% oftotal government subsidies to global energy, at least 6% apparently. (Michael Jefferson, World Renewable Energy Network & Congresses)	Rejected no reference.
4-1633	A	94	0	0	0	Table 4.5.1: The CCS/Tech dev and diffusion box should mention geological CO2 storage as it is the main alternative over ocean storage etc. (Kenneth Möllersten, Swedish Energy Agency)	Accepted: see 4-1619
4-1634	A	95	1	0	0	Insert “that” after “showed” (Danny Harvey, University of Toronto)	Accepted: text changed.
4-1635	A	95	7	95	12	There should be a separate paragraph on the support for renewable energy, energy efficiency - this should not include nuclear energy as there are clearly different support structures for the nuclear industry. These energy technologies should not be discussed together as there are significant environmental issues regarding nuclear energy. (Kirsten Macey, Climate Action Network Europe)	Rejected: text already balanced.
4-1636	A	95	11	95	12	Change 'Some developing countries', to 'A significant number'. The REN21 Global Status Report Executive Summary, for example, states: "Developing countries took new steps in record numbers to incorporate renewables into their energy systems,	Accepted: text modified.

						including programs and new policy developments in Brazil, Chile, Colombia, Egypt, India, Iran,Madagascar,Malaysia,Mexico, Morocco, Pakistan, the Philippines, South Africa, Thailand, Tunisia, Turkey, and Uganda." It is still useful to highlight China, India and Brazil. (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	
4-1637	A	95	15	96	11	For renewable energy policy to be successful in attracting capital, financiers and investors consulted on this topic concluded the key policy characteristics are that it be 'Loud, Long and Legal': impact on the bottom line of a project, stability and duration of the support mechanism, and its design, being key factors to provide market confidence, in addition to increasing experience (therefore less risk) in the technologies. This is written up in: Hamilton, K., 2005. 'The Finance-Policy Gap: Policy Conditions for ooks.g Long-Term Investment'. In Tang, K, ed., 2005. The Finance of Climate Change. London: Risk Books. Investment perspectives are also relevant to section 4.5.1.2 (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	Rejected: These sections already overloaded with references.
4-1638	A	95	16	0	0	Should be "increases" [subject is "setting goals", singular] (Danny Harvey, University of Toronto)	Accepted
4-175	B	95	28	95	30	Regulations and guidelines for implementation of nuclear incentives included in EPACT 2005 are still being developed. Suggest editing last sentence to read "The United States has recently introduced federal loan guarantees that could cover up to 80% of the project costs, production tax credits worth USD 6 billion, and USD 2 billion of risk coverage for investments in new nuclear plants" U.S. Government (Government of U.S. Department of State)	Accepted: text changed
4-176	B	95	29	95	0	"…nuclear and RETs…" Revise sentence to include renewables for loan guarantees and PTCs, but not risk coverage. U.S. Government (Government of U.S. Department of State)	Noted: see 4-175
4-1639	A	95	33	95	33	replace "permitting customers to receive favorable treatment" with 'providing long term price certainty for renewable energy producers' (Steve Sawyer, Greenpeace International)	Accepted: text changed
4-1640	A	95	42	95	44	This implies that feed-in-tarrif is better than RPS, but it depends on the situation of a country. The three pieces of literature are provided here (Ragwitz el al cannot be found in the references), but all seem to assess only the renewable policies in the EU member states. (Koji Kadono, Global Industrial and Social Progress Research Institute(GISPRI))	Noted: reference list will be updated. Inga will provide the two references to Julio.
4-1641	A	95	45	95	47	This section has a primary focus on instruments and policies for renewables.	Noted: see section 4.6

						However, substantial success in reducing emissions has been achieved with policies aimed at fossil based electricity generation in Europe. One clear example has been the UK policy for fuel switching (from coal to gas) which has contributed to a substantial CO2 reduction in the UK. Another clear policy example, with wider application within Europe, are the regulatory and voluntary instruments which have been used to apply minimum efficiency standards to power plants. A third policy area with success forms the introduction of CHP (for instance in Denmark and the Netherlands where CHP has reached large shares in generation of electricity). Additionally in this respect, one could mention the efforts in private (and partly public) R&D which have contributed to increasing generation efficiency. In some cases these R&D efforts have been supported by additional governmental support measures. Given the notion that fossil fuels will continue to dominate energy supply for some decades, it seems wise to devote some more attention to policies which address fossil fuels. (Walter Ruijgrok, EnergieNed)	
4-1642	A	95	45	95	47	There is an additional explanation. Feed-in tariffs have been around for some time and therefore it is logical that this instrument has led to investments. Quota based systems and trading systems have a considerably shorter history and therefore it may take some time before investments under these systems take off (as it also took time for investments to take off under feed-in tariffs). This may explain as well the discrepancy between both systems. (Walter Ruijgrok, EnergieNed)	Noted.
4-1643	A	96	11	0	0	An arrangement has been proposed for integrating quota obligations into a tradable emissions permit system in a way that has dynamic efficiency properties (internalising the learning-by-doing externality) and also improves the integrity of the emissions cap, as well as having the advantages of quota obligations mentioned here (Read, 2006) (Peter Read, Massey University)	Rejected
4-1644	A	96	11	96	11	An arrangement has been proposed for integrating quota obligations into a tradable emissions permit system in a way that has dynamic efficiency properties (internalising the learning-by-doing externality) and also improves the integrity of the emissions cap, as well as having the advantages of quota obligations mentioned here (Read, 2006) (Peter Read, Massey University)	Rejected

4-177	B	96	14	96	0	"…permit systems"…of what? U.S. Government (Government of U.S. Department of State)	Accepted: text updated
4-1645	A	96	21	96	38	It is worth noting that worldwide, it is believed that the private sector accounts for the majority of investments in energy RD&D. In the United States, approximately 2/3 of U.S. energy RD&D expenditures are made by the private sector, and 1/3 by the U.S. government. Although data are incomplete, by most accounts, private-sector RD&D spending is on the decline as well. (Kelly Sims Gallagher, John F. Kennedy School of Government, Harvard University)	Accepted
4-1646	A	96	26	96	30	I encourage the authors to find a better citation from the technical literature that speaks to the many points made in this long sentence. I do not think it is appropriate to cite a piece of US legislation when there is a large technical literature on the role of government in supporting R&D in general and energy R&D in particular. Also I doubt that the Energy Policy Act of 2005 actually speaks to all of the market failures and other impediments listed in this long sentence. (James Dooley, Battelle)	Rejected: no reference provided
4-1647	A	96	32	96	39	The sentence that says about 2/3 of the reduction in funding came from the United States is really troubling to me. I have access to the same data and it seems to me that an equally valid point could be made that during this period a number of national government's made huge cuts in their support for energy R&D United Kingdom (-95%), Germany (-73%), Spain (-82%), Italy (-76%), and France (-55%). The fact that the US accounted for such a large share of the overall reduction stems from the fact that the US and Japan have accounted for nearly 60% of the cummulative total IEA member country support for energy R&D since the early 1970's, i.e., the US suport for energy R&D is so much larger that any reductions will have a disproportante impact on the total level of funding. It would be more productive to take a step back and ask why the public and private sectors around the world either reduced or held constant (in real terms) their support for energy R&D over a period that lasted more than two decades. Or it might be more productive to note that as a percent of national GDP support for energy R&D has been in decline for three decades yet nation's support for other forms of R&D (e.g., medical, defense, IT) has been increasing signficantly. What's going on with energy R&D across the world? That's more important and more interesting than "2/3 of the cuts happened in the U.S." Simply communicating the funding trends is not really that informative. Looking to the literature for some insight about why	Noted.

						these changes occured is likely more useful information. See for example. PJ Runci, JJ Dooley and LE Clarke. Energy R&D Investment in the Industrialized World: Historic and Future Directions. Issues in Science and Technology. Spring 2006, pp. 10-11. PJ Runci and JJ Dooley. Energy Research and Development. Encyclopedia of Energy. Elsevier Science, Spring 2004. JJ Dooley. "Unintended Consequences: Energy R&D in Deregulated Market." Energy Policy. pp. 547-555. June 1998. (James Dooley, Battelle)	
4-1648	A	96	32	96	39	In the second sentence of this paragraph what are these percents in reference to? The share each of these technology areas comprises of total cumulative IEA member country support for energy R&D over the period 1974-2004? The percent decrease from some year to some other year? This sentence needs to be rewritten. (James Dooley, Battelle)	Accepted
4-1649	A	96	32	0	38	It should be specified if the numbers represent real or nominal values. (Government of Sweden)	Accepted
4-1650	A	96	36	96	38	It sounds as though the underlying statistics cover all countries in the world. If these are just samples of countries for which research funding went down it should be made explicit in order to avoid confusion. (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-178	B	96	43	96	0	"…to pay more for electricity"…not always. Remove from text. There are cases where those buying "green" power pay less than "dirty" power. U.S. Government (Government of U.S. Department of State)	Rejected: no reference
4-179	B	96	45	96	47	The authors should review the literature for examples of voluntary energy and emissions savings programmes outside the USA. For example the Australia's Greenhouse Challenge Plus programme. (Government of Australia)	Rejected: no reference
4-1651	A	97	2	97	2	Introduce 'For these reasons more R+D investment in sociological research is needed to improve the adequate information instruments for climate change mitigation and adaptation'. (Government of Spain)	Accepted: sentence added
4-1652	A	97	3	0	0	Just as variety of technologies will be needed, can note that variety of policies will likely also be needed. (Joanna Lewis, Pew Center on Global Climate Change)	Rejected: no reference
4-1653	A	97	5	97	45	The experiences focus primarily on renewables. However, given the notion that	Rejected

						fossil fuels will continue to dominate energy supply, more attention to successful policies which help reduce CO2 emissions from fossil generation is appropriate. See comment (10) here above. For instance in the UK, fuel switch policies in the past have contributed to larger CO2 emission reductions in the UK than the renewables policy of the UK which is mentioned in lines 35-45. (Walter Ruijgrok, EnergieNed)	
4-180	B	97	5	98	32	Section 4.5.1.2 has a strong European bias with 5 out of 7 examples of technology implementation being provided from Europe. The authors should review the literature for examples of technology deployment outside Europe. (Government of Australia)	Noted
4-1654	A	97	14	97	17	The Danish wind power experience has not, in some important respects, been a success.Inflexibility of the grid system has not helped, but the costs to the Danish electricity consumer have been higher than anywhere else in Europe for between 4% and 6% of their domestic electricity consumption. Other countries have arguably benefited, notably Norway, but is that the criterion of success? (Michael Jefferson, World Renewable Energy Network & Congresses)	Rejected
4-1655	A	97	19	98	21	P36 of chapter 4 states that Spanish wind power, Japanese PV and Swedish biomass utilisation are examples of renewables that are “competitive” on their respective markets. The information that the success of these technologies on their respective markets has been strongly related to promoting economic and legal instruments is strongly contradictory to the text on P36. (Kenneth Möllersten, Swedish Energy Agency)	Rejected
4-1656	A	97	19	97	23	Germany has achieved some of the lowest capacity (load) factors for its turbines of anywhere in the world, down as low as 10% for some inland developments. Thus although in some respects the Feed in tariff system has worked relatively well, there has arguably been a serious misallocation of national resources. Meanwhile, Germany remains Europe's largest single CO2 emitter. (Michael Jefferson, World Renewable Energy Network & Congresses)	Rejected
4-1657	A	97	24	0	0	Include Gan et al. 2006. (Government of Norwegian Pollution Control Authority)	Noted: referenced will be checked
4-1658	A	97	30	97	30	I think that there is a "not" missing in the statement "in order to pay income tax", and while you've said you don't want minor copy-edits, this changes the sense! (Richard Green, University of Birmingham)	Accepted: text changed
4-1659	A	97	40	0	42	P97, 40-42: How can it be claimed that “an obligation on electricity suppliers to sell a minimum percentage of power from new renewable energy sources” is “a more	Accepted: text changed

						market-driven support mechanism"? (Government of Sweden)	
4-181	B	97	43	97	0	"…generation by eligible plant" Define "eligible". U.S. Government (Government of U.S. Department of State)	Accepted: word changed
4-1660	A	97	44	97	45	I don't know what you count as "many" in the statement "the obligation has not been able to stimulate many new large-scale developments". There are currently 7 wind farms in Great Britain with a capacity of over 50MW (National Grid Company Seven Year Statement for 2006, table 3.5, at www.nationalgrid.com). The Statement lists 15 schemes with a capacity of more than 100 MW, and a further 22 with capacities of 50-99 MW, that have signed agreements for connection by 2013, though experience suggests not all of these will actually go forward. (Richard Green, University of Birmingham)	Accepted: text changed
4-1661	A	98	5	0	7	The statement is not easy for the reader to understand. Refer to the fourth Swedish national communication to the UNFCCC for an overview of Swedish policy instruments that promote biomass. (Government of Sweden)	Accepted: text modified
4-1662	A	98	12	98	21	Need to mention recent California expansion plan to aid in the installation of 3000 MW of solar power in the residential sector. http://www.environmentcalifornia.org/newsroom/energy/energy-program-news/million-solar-roofs-bill-sb-1-signed-into-law#1H202IC_O9f0derEDnExjw (John Nyboer, Simon Fraser University)	Accepted: California added
4-182	B	98	30	98	31	Why not mention new law and the new nth 10 year plan goals? U.S. Government (Government of U.S. Department of State)	Rejected: comment not understandable
4-1663	A	99	4	99	4	BBC is not a scientific reference. I suggest the use of data provided by WHO reports (Stefano Caserini, Politecnico di Milano)	Accepted: Reference deleted
4-183	B	99	21	0	0	Replace "double" with "multiple". U.S. Government (Government of U.S. Department of State)	Accepted: text changed
4-1664	A	100	14	100	14	Add 'reduction of energy use' after 'improvements'. (Government of Spain)	Accepted: text added
4-1665	A	100	29	0	0	Under ambient air quality standards, (4.5.2 p30), mention is made on SO2 and its removal vis-à-vis, removal of CO2. It appears that these are competing processes. But in actual reality, any removal of CO2 by liquid solvent or solid adsorbent, there	Rejected

						is a need for removal of SO2 for meeting the requirements of CO2. In fact this is major issue when one is handling low sulfur coal where requirement of SO2 removal from environment point of view is not necessary but would need to be put in place if capture process for CO2 is required. This adds to the CO2 capture costs. (Government of India)	
4-1666	A	101	10	0	15	Good that it is referred to Ch 11 for co-benefits of mitigation policies, but it ought to be stated more clearly what is the purpose and focus of the current section. It seems it is not only dealing with aspects specifically related to energy supply - as is stated. The section lacks a clear focus and is not well organised. (Kristin Aunan, Center for International Climate and Environmental Research - Oslo (CICERO))	Rejected
4-1667	A	101	12	0	0	Including nuclear energy in the section on co-benefits is misleading as there are several risks associated with this technology that should be highlighted. (Kirsten Macey, Climate Action Network Europe)	Rejected
4-1668	A	101	13	101	13	Include 'and energy use reduction' after 'efficiency' (Government of Spain)	Rejected
4-1669	A	101	20	0	0	The sentence 'In most cases the co-benefits of GHG mitigation are defined from the macroeconomic point of view...' seems odd. What is meant? Maybe socioeconomic point of view? As shown in Chapter 11 co-benefits are defined and estimated by means of different methodologies – from detailed local case-studies to economy-wide macroeconomic models. The sentence may be deleted. The section would benefit from referring to concrete assessments of co-benefits of GHG mitigation options directed towards the energy supply sector. For instance it is shown that the local co-benefits from energy saving in coal fired power plant (which typically have high stacks) may be much lower than from corresponding measures in area sources. However, the power sector as such has overall large emissions contributing substantially to regional air pollution. These emissions contribute to exposure (of people, crops and natural vegetation) to secondary pollutants (e.g. Pm2.5 and ozone) in vaste regions (see Mestl, H.E.S., K. Aunan, J. Fang, H.M. Seip, J.M. Skjelvik and H. Vennemo, 2005. Cleaner production as climate investment – Integrated assessment in Taiyuan City, China. Journal of Cleaner Production, 13: pp. 57-70.) (Kristin Aunan, Center for International Climate and Environmental Research - Oslo (CICERO))	Accepted: sentence deleted

4-1670	A	101	23	0	0	After '..lack of information' you may add: , although new studies are emerging incorporating a broader scope of end-points (e.g. avoided agricultural crop loss from reduced surface ozone levels described in Aunan et al., 2006a and 2006b). References. Aunan, Kristin, Terje Berntsen, D. O'Connor, Therese Hindman Persson, Haakon Vennemo and F. Zhai, 2006. Benefits and Costs to China of a Climate Policy. Environmental Development Economics, (Accepted). Aunan, Kristin, Jinghua Fang, Tao Hu, Hans Martin Seip and Haakon Vennemo, 2006. Climate change and air quality – measures with co-benefits in China. Environmental Science and Technology, 40, 4822-4829. (Kristin Aunan, Center for International Climate and Environmental Research - Oslo (CICERO))	Rejected: Too much details
4-184	B	101	27	102	0	"…employment…where implemented in rural areas, co-benefit of reducing urban migration" U.S. Government (Government of U.S. Department of State)	Accepted: text added
4-1671	A	101	29	101	29	Suggest adding an 'energy security' subheading (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	Rejected
4-1672	A	101	40	0	0	Insert "enhanced" before "economic" (Danny Harvey, University of Toronto)	Accepted: word added
4-1673	A	102	18	102	20	Chapter 2, Section 2.8 could perhaps be cross-referenced here. (Danny Harvey, University of Toronto)	Rejected
4-185	B	102	18	102	0	"…inevitably expensive during". Replace "inevitably expensive" with "typically more expensive" U.S. Government (Government of U.S. Department of State)	Accepted: text changed
4-1674	A	102	25	102	34	This section mentions job creation as a co-benefit of mitigation. This is, however, only true from the perspective of the entire economy if investments in renewables lead to an absolute net growth of jobs. Replacement of jobs (e.g. from one part of the energy sector to another part of the energy sector) delivers no real economic benefits or net job growth. The number of jobs mentioned for the EU is not a net growth of jobs, but typically a replacement. For developing countries the situation, however, may differ. (Walter Ruijgrok, EnergieNed)	Rejected: no reference
4-1675	A	102	32	0	0	For the number of 900,000 new jobs created by the development of renewable energy technologies the methodological background of the study should be clear. A bottom-up study, adding job creation technolgy by technology, differs from a	Rejected

						macro-economic analsis which takes into account the effects of high energy prices and subsidization for the overall economy. Due to high energy prices there might be a contrary development with respect to job creation in non-renewable energy sectors. (Wilhelm Kuckshinrichs, Forschungszentrum Juelich GmbH)	
4-186	B	102	35	101	39	Section should be written more succinctly U.S. Government (Government of U.S. Department of State)	Rejected
4-1676	A	102	41	0	0	Section 4.5.4. There is scope to get this section much shorter. In general, the subsections passess superfitialy trough very big issues and then falls randomly to incredibly detail ones. Example of the first is 4.5.4.4 (page 106), with wordy text, empty of meaning like: "It is important to focus on improving productive uses of energy as a way of contributing to income generation. They should be seen as a way to provide services and not as an end in themselves" ....Example of sections with unnecessary details (and associated unnecessary references) are is 4.5.4.1 : I guess there are thousands of references in the world about problems to humans or to the environment caused from leakages and accidents related with fossil fuels, so why do we need to read hear about these 3-4 cases only?. (JUAN CARLOS ABANADES, INCAR-CSIC)	Rejected
4-1677	A	102	0	0	0	The section 4.5.4 on “Implications of energy supply on sustainable development” could cite some other useful references, such as Modi, V., McDade, S., Lallement, D., and Saghir, J., 2004. Energy services for the Millennium Development Goals. Commissioned paper for the Millennium Project Task Force 1. http://www.unmillenniumproject.org/documents/MP_Energy_Low_Res.pdf (Government of India)	Rejected
4-1678	A	103	2	0	0	I don't think a text analysis can 'show that renewable energy projects provide the most sustainable impacts', it can at the most 'indicate'. (Kristin Aunan, Center for International Climate and Environmental Research - Oslo (CICERO))	Accepted: text changed
4-1679	A	103	2	0	0	Insert “that” after “showed” (Danny Harvey, University of Toronto)	Accepted: text changed
4-1680	A	103	9	47	0	This sections seems disconnected from the rest of the chapter and is not well organised. (Kristin Aunan, Center for International Climate and Environmental Research - Oslo (CICERO))	Rejected
4-1681	A	103	10	103	47	This part deals with the health problems caused by energy supply. Moreover these	Rejected: no reference

						health problems are still detailed in section 4.5.2 Air quality and pollution page 98, but this time it is more on traditional energy supply. Only one sub-section which traces back the health problems linked to energy supply would have helped to envisage this problem from all angles. It will be interesting to mention the new study of the World Health Organization, Fuel for Life: Household Energy and Health, for these questions. (NOGOYE THIAM, ENDA- TM)	
4-1682	A	103	11	103	14	It seems that winter deaths it is a similar problem than respiratory deseases nowadays (Félix Hernández, Economía y Geografía. Consejo Superior de Investigaciones Científicas (IEG-CSIC))	Rejected
4-1683	A	103	12	103	12	Correct into a lack of or an insufficient home heating (Government of France)	Accepted: text changed
4-187	B	103	24	103	27	Mention RSA indoor air quality studies and costs U.S. Government (Government of U.S. Department of State)	Rejected: no reference
4-1684	A	103	37	0	0	the use of the word 'cracks' is not fully correct, as many failures are deliberate sabotage, rather than engineering failure, which of course does happen as well. (Chris Mottershead, BP)	Acccpted: text changed
4-1685	A	104	3	104	23	In this section 4.5.4.2 Equity and shared responsibility, you spoke of the impact of reforms in the energy sector that have thus created a problem of equity as a result of high tariffs. Another problem of inequality, and this time that is harmful to our environment, should be spelt out here. In fact in most countries south of the Sahara, the negotiations for the adoption of reforms have led long talks almost everywhere in order to stop investment in the electricity sector. On the other hand, once the reforms are undertaken, and the private companies which are often owned by foreigners and are profit-making either are slow in undertaking necessary investments, or request for an additional increase of the tariffs and this has led to many breaches of privatisation contracts in many countries (Senegal, Mali, Togo). The lateness in investments and moreover the problems of supply of oil products in some countries, end in frequent power cuts that paralyse the economy. The response proffered by the populations that have the means, is to purchase electric generators to make up for the lack of electricity. However, the latter seriously pollutes the atmosphere. The « lower income earners » do not only have access to electricity, but particularly suffer from the pollution. The concept “polluter/polluted” is present here at the local level.	Rejected: no reference

						(NOGOYE THIAM, ENDA- TM)	
4-1686	A	104	4	104	5	What does "the poorer the economic performance mean"? GDP/person, growth rate, efficiency in providing goods and services, or what? (Danny Harvey, University of Toronto)	Noted: text improved
4-1687	A	104	11	0	12	The sentence that starts 'The advent…' is confused, as the energy sector can certainly increase inequalities, but that has nothing to do with multinationals benefiting, that is a separate issue, the inequalities of concern (curse of oil or Dutch Diseases) are those within the local economies and its relationship to other economies. No references are given, perhaps a reference to the work of Paul Stevens. This is a separate issue from governments choosing to impose market rates, and decrease energy subsidies, which can clearly increase fuel poverty. I think at least three separate ideas are mixed here. (Chris Mottershead, BP)	Accepted: Text changed
4-1688	A	104	16	104	16	Change "injustices" to "issues." Whether a situation is "unjust" is a value judgment and IPCC authors should not be making value judgments. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted: text changed
4-188	B	104	16	104	16	Change "injustices" to "issues. Whether a situation is "unjust" is a value judgment and IPCC authors should not be making value judgments. U.S. Government (Government of U.S. Department of State)	Accepted: text changed
4-1689	A	104	27	104	45	No mention is made in this discussion of the problem that traditional financing/lending criteria do not find it easy to accommodate investments with high front-endcosts although the cost of the renewable energy input is modest to virtually free. (Michael Jefferson, World Renewable Energy Network & Congresses)	Rejected: no reference
4-189	B	104	30	104	0	These amounts are Not significant regarding private capital, but private investors are not sufficiently attracted to the investment opportunities given risks and returns. U.S. Government (Government of U.S. Department of State)	Noted
4-1690	A	104	40	0	0	"is" should be "are" (Danny Harvey, University of Toronto)	Accepted: text changed
4-1691	A	105	4	105	5	Suggest adding sentence about actual investment issues, in addition to the overall numbers. Paul van Aalst's Background Information Paper to a UNFCCC workshop on Innovative Finance Options for Technology Transfer (www.unfccc.int), September 2004; and O'Brien and Usher's 2004 paper: 'Mobilising Finance for	Rejected

						Renewable Energies, Thematic background paper' for the International Conference for Renewable Energies, June 2004, outline some key gaps in finance for different levels of need, and solutions. It is not just quantity of capital but at an appropriate cost - national policy frameworks, local bank engagement, means to underwrite the creditworthiness of local enterprises all lower risks and reduce the cost of accessing finance. van Aalst's paper reference's the EU's 'Patient Capital Initiative' which aims to form a 'Fund of Funds' that blends private and public funding and which will offer investors a modest long term financial return ("patient" capital); it can then be used for small scale low cost loans to entrepreneurs and small businesses, or others seeking a source of lower cost capital. The World Energy Investment Outlook 2003 , also raises investment specific issues. Reiterating the opportunity to integrate this with a response to energy security matters is useful. (Kirsty Hamilton, Chatham House; UK Business Council for Sustainable Energy)	
4-1692	A	106	9	0	0	After "themselves" insert "For instance, the holistic strategy, a precautionary response to potential abrupt climate change (Chapter 2, Section 2.3.4) involves socio-economically and environmentally sustainable land use improvement and necessarily generates rural employment. It also provides cash income from externally marketed liquid biofuels and potential for local thermal electric generation using ligneous residues for fuel. (Read and Lermit, 2005. Read Sims and Adams 200x)" (Peter Read, Massey University)	Rejected
4-1693	A	106	9	106	9	After "themselves" insert "For instance, the holistic strategy, a precautionary response to potential abrupt climate change (Chapter 2, Section 2.3.4) involves socio-economically and environmentally sustainable land use improvement and necessarily generates rural employment. It also provides cash income from externally marketed liquid biofuels and potential for local thermal electric generation using ligneous residues for fuel. (Read and Lermit, 2005. Read Sims and Adams 200x)" (Peter Read, Massey University)	Identical to 4-1693
4-1694	A	106	35	106	47	These are weak pieces of text: "higher ambient temperatures may affect efficiency and capacity ratings" (they certainly will, and it should be quite easy to estimate how much, asking to a mechanical engineer how these change with a 1-2 degree increase in ambient temperature). If this is irrelevant, do not write anything, if this is relevant, write how much). The same applies to the paragraph on the effect of climate change on renewables and the associated reference (Sims, 2003). In the	Rejected

						same sentence, lower precipitation goes with higher evaporation?. These may cause lower levels of water in rivers and lakes; but then, a reference to "increased cloud cover" is used to justify lower solar ?. Can we have increased cloud cover and lower precipitation ?. (JUAN CARLOS ABANADES, INCAR-CSIC)	
4-1695	A	107	10	107	40	I was a bit confused about this section, it would perhaps read better to have specific technologies mentioned for example solar power, bionergy, nuclear, CCS and what amount of money is being spent in R&D as well as the barriers for R&D deployment which are not mentioned at all. See the two expert meetings held with industry and some of the conclusions and recommendations to overcome the barriers to R&D and deployment (John Kessels, Energy Research Centre of the Netherlands)	Rejected
4-1696	A	107	10	107	14	Energy storage is an important research topics which should be more insisted upon (Government of France)	Noted: Energy storage treated in section 4.3.7
4-1697	A	107	44	0	0	This WEC 2001 reference is incorrect (see page 127, line 27), the report mentioned was on Energy RD&D expenditure. Bob Schock will have the correct reference to hand. (Michael Jefferson, World Renewable Energy Network & Congresses)	Accepted
4-1698	A	107	0	0	0	Section 4.6 could provide cross-reference to chapter 2 for technology. (Government of India)	Rejected
4-1699	A	108	1	108	5	Please see the discussion on pages 22-23 of Chapter 13 of the Second Order Daft of AR4 for a much more balanced presentation of these IEA energy R&D funding data. (James Dooley, Battelle)	Rejected
4-1700	A	108	1	108	5	Figure 4.6.1. The graphich that shows renewable energy R&D per capita needs to be deleted. That is a completely meaningless statistic. If their were 3 researchers in Vatican City or Lichtenstied that working on renewable energy technology, I am sure these nations would show up prominetly on this graphic. But how relevant would that information be? Isnt the gross dollar amount spent on a particular energy R&D area a better measure of what kind of technical progress might be forthcomming? Shouldnt that be the focus of this section rather than some countries like renewable energy R&D more than others? Also why does this graphic only focus on renewables, the text is speaking to changes in overall spending levels and changing priorities across all energy R&D technlogy areas.	Rejected

						Wouldnt it be better to get the IEA data and show how overall support for nuclear, fossil fuels, renewables, conservation, etc has changed since the late 1970s - early 1980s? (James Dooley, Battelle)	
4-1701	A	108	1	0	0	Figure 4.6.1: In the U.S. government-funded financial incentives for deployment of new energy technologies are greater in overall magnitude than government R&D investments in new energy sources and conservation. In Europe they are also greater. Statistics on these incentives should be provided, since they are greater in magnitude to the statistics on government investment that are provided. Statistics for private investment should be included as well. (Robert Goldston, Princeton Plasma Physics Laboratory)	Rejected: no reference
4-1702	A	108	2	108	2	After 'change.', insert: 'It is salutary to note that the total annual energy-related R&D expenditure shown in Figure 1.9 is equal to only one day of consumer spending on the international energy markets!' (Ian Cook, United Kingdom Atomic Energy Authority)	Rejected
4-1703	A	108	3	108	6	Figure 4.6.1 is interesting information but I would strongly suggest putting the breakdown for the IEA countries total energy R&D budgets, which the IEA has in various publications…and is reprinted as Figure 1.9 in the current draft of Chapter 1 of the WG III Second Order Draft (Steve Sawyer, Greenpeace International)	Rejected
4-1704	A	108	4	0	0	Figure 4.6.1 is also included as Figure 13.2 (but in ch13 with older data). Because the detailed information on R&D for energy technologies fits with the technology sections in Ch4, I would propose to leave the figure in ch4 and take it out of ch 13. See however also the simplified fig 1.9, which chapter 1 uses in a nice argument. (Peter Bosch, IPCC TSU)	Accepted
4-190	B	108	25	108	0	In the U.S. government funded financial incentives for deployment of new energy technologies are equal in overall magnitude to government R&D investments in new energy sources and conservation. In Europe they are greater. Statistics on these incentives should be provided, since they are similar in magnitude to the statistics on government investment that are provided. Statistics for private investment should be included as well. Revise to state U.S. investments are 1.7B USD in Energy R&D and 3B USD for financial incentives for deployment. U.S. Government (Government of U.S. Department of State)	Noted
4-1705	A	108	0	0	0	Figure 4.6.1 - would be useful to incorporate all energy R&D, not just renewables if	Noted

						possible (Christine Copley, World Coal Institute)	
4-1706	A	109	4	109	5	Change this sentence to "The private sector invests a significant amount in energy RD3 to seek competitive advantage through improved technology and risk avoidance." See, for example, the Global Climate and Energy Project (GCEP) at Stanford University (www.gcep.stanford.edu), a 10 year, $225 million project funded by the private sector, to develop innovative new energy technology that could significantly reduce GHG emissions from energy use. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted
4-191	B	109	4	109	5	Change this sentence to "The private sector invests a significant amount in energy RD3 to seek competitive advantage through improved technology and risk avoidance." See, for example, the Global Climate and Energy Project (GCEP) at Stanford University (www.gcep.stanford.edu), a 10 year, $225 million project funded by the private sector, to develop innovative new energy technology that could significantly reduce GHG emissions from energy use. U.S. Government (Government of U.S. Department of State)	Accepted
4-1707	A	109	5	0	6	No evidence is provide to support the assertion that firms tend to invest in RD3 at less than socially optimal levels. (Chris Mottershead, BP)	Rejected
4-1708	A	109	7	0	0	Not clear why utilities should invest more than 1%, they are largely none technical organisations procuring technology from manufacturers, who do invest significant amounts in RD3. The overall point seems confused, why would you expect any relationship between these very different sectors. (Chris Mottershead, BP)	Noted
4-1709	A	109	10	109	14	The part of text has a too negative tonality for private sector R&D ("insufficient investment", "decline significantly"…) according to all others mentions of "private-public R&D" which are well moderating the feeling according to "stabilisation target", "cost reductions" and "incentives" (refer to SPM p7 + ch2 p78 + TS p104 lignes14-26) (Brigitte POOT, Total s.a.)	Accepted: text changed
4-1710	A	109	15	0	33	This is a set of very strong assertions about the importance of increased RD3 and the structure of its management, and it might be a widely held one, but what is the evidence to support the assertions. (Chris Mottershead, BP)	Accepted: text changed
4-192	B	109	20	0	0	Add: In addition, such laws can contain elements to promote innovation, such as	Rejected: too detailed

						the degression of the feed-in tariff and the innovation bonus (rewarding the use of innovative technologies such as biogas processing, Stirling engines etc.) in the German Renewable Energy Act. (Government of Germany)	
4-1711	A	109	35	0	0	Do you mean supplying developing and developed country needs for energy. You can add IEA 2006a as a reference for this statement, as a key finding is that global R&D investment in the energy sector has to rise if we are to reduce and eventually stabilise GHG emissions at a level that minimises climate change costs. (Michael Taylor, International Energy Agency)	Accepted
4-1712	A	109	37	0	0	Insert “that” after “ensure” (Danny Harvey, University of Toronto)	Accepted

Comments on section 4.7 Joergen + Hans

4-1713	A	110	3	110	4	As described in lines 6 and 7 we know that we have to avoid emissions to grow for the next decades if we stick to Art 2 of FCCC. Therefore please give the condition of unconstrained development already in the sentence in lines 3 and 4 '... Without effective regulation to reduce emissions the trend of increasing GHG emissions will continue over the next several decades ...' (Manfred Treber, Germanwatch)	Accepted: text changed
4-1714	A	110	3	110	5	Suggestion replacing the second sentence of this para with "The trend of increasing GHG emissions will continue over the next several decades, and possibly throughout the 21st century, unless governments intervene with policies, measures and financial support aimed at avoiding dangerous climate change, addressing local environmental and health issues, and enhancing energy security. This is especially true in the energy-supply sector. (Steve Sawyer, Greenpeace International)	Noted: new text
4-199	B	110	4	110	0	Disagree with the statement that the current technological adoption path will not come close to meeting the goal of article 2 of the UNFCCC to stabilize concentrations in the -------climate system. Factual Information: - It appears that major emissions of carbon dioxide will come from the developing Annex II countries. Therefore the path (strategy) to stabilization should fully include the needs, time frame, and ability of these countries to adopt this path. These countries are relatively poor and with little capital available to invest in technology development and to change the infrastructure for a new energy	Noted: The whole text in section 4.7 has been changed.

						economy -Consequently, these developing countries need time to grow their economies while revolutionary technologies are being developed by the U.S. and other wealthy Nations -Therefore, a path to stabilization is needed that would work best for both Annex 1 and II countries simultaneously in terms of timing and adoptionIssues and ConcernsThere is no discussion of technology deployment schedules. Deployment time frame for technologies defines the path to stabilization. -Cost for deploying a new infrastructure for an emerging energy economy can be excessive to the point that many countries would not be able to afford the change due to lack of capital. EVEN if the technologies are handed over at no charge to these countries. Most of US electricity plants were deployed in the 1970s to 1980s timeframe – these plants have a 60 year life [The Fifth International Conference on Greenhouse Gas Control Technologies, Australia, 2000]. A forced early change in capital stock turnover for US or any other country would be extremely damaging to the economy. -Many different paths to stabilization are possible – Each can lead to stabilization at reasonable levels but with different strategies for technology deployment. The optimum path would allow time to grow the economies of countries, especially developing countries, and then put revolutionary technology to use to rapidly reduce emissions. This allows additional time to develop a handful of revolutionary technologies that can be deployed globally level (because these are only a very few technologies) quickly, and at low cost (since time is allowed for economies to grow capital is available for deployment of technology and for infrastructure changes). -The climate issue has emerged over a century of anthropogenic actions and trying to fit it into a thirty year remedial strategy is like trying to fit a 1000 pound gorilla in a 100 pound cage. Cannot be done by policy measures alone without regard to availability, cost of technology and cost to the economy. Actions taken too quickly in a FORCED-FIT fashion could lead to consequences that are much worse than if more time was given to addressing the issue. Abatement costs reduce with time- a key factor in the proposed strategy of course is TIME --necessary to grow the economies of the developing countries, especially China and India, and TIME needed to develop just a handful of technologies that can be more easily adopted at a global scale and that can reduce emissions rapidly.	

						BOTTOM LINE-Just a few technologies- revolutionary in nature will be able to address the issue. The fact remains that the approach to stabilize GHG should strongly consider -----not how soon you deploy evolutionary technologies BUT how fast you can reduce emissions with one handful of revolutionary technologies when these technologies are deployed Two Areas of Research That Need Further Attention and R&D-Reduce Uncertainty in Climate Feedback Due to Clouds, Water vapor and Albedo-Conduct research to restore climate to normalcy from a "Runaway" situation U.S. Government (Government of U.S. Department of State)	
4-193	B	110	5	110	8	Delete sentence beginning "The current….will not come close to …meeting the goal of Article 2 of the UNFCCC." As expressed in an earlier chapter of the WG3 report, it is not up to the IPCC to make judgements about the policies and targets that will meet the goal of Article 2. (Government of Australia)	Noted: The whole text in section 4.7 has been changed.
4-194	B	110	5	110	0	"…energy-supply sector…unless significant policy changes are adopted world-wide" This sentence is overly pessimistic. U.S. Government (Government of U.S. Department of State)	Noted: The whole text in section 4.7 has been changed.
4-1715	A	110	8	0	0	The goal of the UNFCCC is not merely to avoid dangerous climatic change (DCC), it is to avoid dangerous anthropogenic interference (DAI) in the climate system (and certainly the goal is not to avoid "damage" to the climate system). The two are not the same. Avoiding DAI means avoiding GHG concentrations that have the possibility of provoking dangerous changes in climate. If we allow GHG concentrations that could have caused dangerous climatic change and then, by pure luck, climate sensitivity turns out to be much smaller than expected (say, at the 5th percentile of the probability distribution function for climate sensitivity), we have avoided DCC but we still violated Article 2 because the GHG concentration was nevertheless dangerous (in the same way that driving a bus full of kids through a red light is dangerous if even an accident does not occur). Thus, change "anthropogenic damage to" to "dangerous anthropogenic interference in" After "system.", add: "Indeed, recent analysis that are consistent with the probability distribution function for climate sensitivity found in WG1 (Chapter 9, Sections 9.6.2 and 9.6.3, and Chapter 10, Sections 10.5.2 and 10.5.4) and of the temperature thresholds for significant negative impacts given in WG2 (Chapter 4, Table 4.2) suggest that the current CO2 concentration may already constitute dangerous anthropogenic interference in the climate system (Harvey, 2006a,b)."	Noted: The whole text in section 4.7 has been changed.

						REFERENCES: Harvey, L.D.D. 2006a. Dangerous Anthropogenic Interference, Dangerous Climatic Change, and Harmful Climatic Change: Non-Trivial Distinctions with Significant Policy Implications. Climatic Change (accepted). Harvey, L.D.D. 2006b. Allowable CO2 Concentrations Under the United Nations Framework Convention on Climate Change as a Function of the Climate Sensitivity PDF. Environmental Research Letters (submitted). (Danny Harvey, University of Toronto)	
4-1716	A	110	12	0	0	Change “are” to “is” [subject is “range”] (Danny Harvey, University of Toronto)	Accepted: text changed
4-1717	A	110	13	110	15	This sentence is inconsistent with the descriptions on lines 5-9 in p.15 and therefore should be changed. (Keigo Akimoto, Research Institute of Innovative Technology for the Earth (RITE))	Noted: The whole text in section 4.7 has been changed.
4-1718	A	110	14	110	15	I find this sentence very policy relevant. page110: renewable technologies would be competitive "if it were not for goverment support...for fossil fuels" ¡¡ . Subsidies on fossil energy are quantifyed in page 94, line 18 at "USD250-300 billion/yr". When I divide this number by the final energy consumption in the world (Table 4.2.1) I get about 1 USD /GJ ¡¡¡ of subsidy on fossil fuels, which is truly a huge number, considering that this is an average subsidiy all over the world, for all energy forms (including gas and oil) ¡¡ and is in the order of magnitude of prices for coal in many parts of the world. However, when I look at the single reference used to support these numbers (De Moor, 2001; do the other references in the same paragraph support this number?) I discover that Iran and Venezuela are subsidizing their oil use ¡¡¡ (but in this case, subsidy only means that their citizens get cheaper oil that at international prices). But then, I find it impossible to accept the notion that in Venezuela or Iran "renewable technologies would be competitive if it were not for goverment support...for fossil fuels", in this case oil. The same applies to coal in China or Australia. In summary and back to the key point: do the Lead Authors of the Energy Chapter of the IPCC AR believe that Goverment subsidies are a significant cause of fossil fuel dominance in the energy supply in the world today?. If those subsidies were removed, or had not existed, would we have a truly different energy supply mix today ?. Whatever the answer is for both questions, they need to be clear in htis section and move up to the executive summary and the	Noted

						SPM and TS. If the answer is yes (as it is now in section 4.7 and in the executive summary), I reccomend they expand in the report the justification of such a bold statement and figures. If the answer is no, they must delete this sentece from the executive summary and the similar text in the SPM and TS and disregard the single reference used (peer reviewed?) to suppport the above critical data. (JUAN CARLOS ABANADES, INCAR-CSIC)	
4-1719	A	110	15	110	20	Because of increasing contraints to new, large and conventional energy systems, there are increasing restricitions to its environmental licensing; this also lead to market competitiveness of renewable energy solutions; this is a key factor for developing countries. (Demóstenes Barbosa da Silva, AES Brazil)	Noted
4-195	B	110	19	110	0	Remove ”through the adoption of new supply technologies. U.S. Government (Government of U.S. Department of State)	Noted: The whole text in section 4.7 has been changed.
4-1720	A	110	20	110	22	"Other higher carbon alternatives……CCS, GHG……negated". The ground fact is that the investors are not considering CCS or such options in their tar sands etc. projects because it makes their project further uneconomical. Special consideration are received by their project from their governments which in effect subsidize their carbon commitments e.g OPTI Canada Inc. reports in its annual information dated March 1, 2006 that Canadian Association of Petroleum Producers has received the Federal commitment according to which they would have to purchase CO2 credits for only 15 percent of their emissions and the price of credits will be capped at $15/tonne. (Government of India)	Noted: The whole text in section 4.7 has been changed.
4-1721	A	110	22	0	0	The Concluding Statement is not very focused. Table 4.4.5 indicates that if we do everything reasonable to achieve, we avoid 4.23 GtCO2 in 2030. This is a major accomplishment, the equivalent of about 50 EJ of non-CO2 emitting energy per year, but only 1/3 of what will be needed in 2050 and 10% of what will be needed in 2100. I think it would be appropriate to put this key result in perspective and restate the scale and long-term nature of the problem: “The more aggressive mitigation scenario discussed in this chapter, for the period until 2030, puts the CO2 concentration curve on a path towards equilibration at 550 ppm or less. However, at the end of this period new non-baseline non-CO2 emitting energy production contributes only about 50 EJ/year. For median mitigation scenarios it will be necessary to provide non-CO2-emitting power in the range of 150 EJ/year by 2050, 500 EJ/year by 2100 and over 1000 EJ/year during the next century, while	Noted

						ultimately limiting CO2-emitting power to a small fraction of this level. The total requirement over the period until 2200 is in the range of 100,000 EJ. To address this problem requires not only the aggressive measures indicated for the period up to 2030, but also large-scale new non-CO2-emitting energy resources that, in aggregate, are not limited in their fractional market penetration. New technologies thus need to be developed that can almost fully replace carbon-emitting technologies in the long run." (Robert Goldston, Princeton Plasma Physics Laboratory)	
4-196	B	110	24	110	0	The Concluding Statement is not very focused. Table 4.4.5 indicates that if the profession does everything reasonable to achieve, avoiding 4.23 GtCO2 in 2030 is possible. This is a major accomplishment, the equivalent of about 50 EJ of non-CO2 emitting energy per year, but only 1/3 of what will be needed in 2050 and 10% of what will be needed in 2100. This number should be squared with the charts shown for example as SPM 2.Put this key result in perspective and restate the scale and long-term nature of the problem: "The more aggressive mitigation scenario discussed in this chapter, for the period until 2030, puts the CO2 concentration curve on a path towards equilibration at 550 ppm or less. However, at the end of this period new non-baseline non-CO2 emitting energy production contributes only about 50 EJ/year.For median mitigation scenarios it will be necessary to provide non-CO2-emitting power in the range of 150 EJ/year by 2050, 500 EJ/year by 2100 and over 1000 EJ/year during the next century, while ultimately limiting CO2-emitting power to a small fraction of this level. The total requirement over the period until 2200 is in the range of 100,000 EJ. To address this problem requires not only the aggressive measures indicated for the period up to 2030, but also large-scale new non-CO2-emitting energy resources that, in aggregate, are not limited in their fractional market penetration. New technologies thus need to be developed that can almost fully replace carbon-emitting technologies in the long run." U.S. Government (Government of U.S. Department of State)	Same comment as 4-1721
4-197	B	110	24	110	28	This paragraph not adequately summarises the chapter (CCS and nuclear are not necessarily required) (Government of Germany)	Noted: The whole text in section 4.7 has been changed.
4-1722	A	110	26	110	26	After 'power,' insert 'fusion'. (Ian Cook, United Kingdom Atomic Energy Authority)	Rejected
4-1723	A	110	29	110	0	Is there something missing as their was a couple of sections quoted in the chapter	Noted: The whole text in section 4.7 has been

						that were under 4.7 but do not appear? (John Kessels, Energy Research Centre of the Netherlands)	changed.

Comments on References Julio

4-1724	A	111	0	128	0	References to be added to existing list: ▪ The International Journal on Hydropower & Dams, 2006 World Atlas & Industry Guide, UK, 2006 ▪ F. Lempérière, ICOLD committee on Governance of Dams, "The role of dams in the XXI century", Hydropower & Dams, issue Three, 2006, p. 99-108 ▪ International Energy Agency Hydropower Agreement, Hydropower and the Environment: Present Context and Guidelines for Future Action, second edition October 2000 ▪ International Hydropower Association, Sustainability Guidelines, February 2004, IHA Internet site ▪ WEC, A Special Report of the World Energy Council, Comparison of Energy Systems using Life Cycle Assessment, July 2004 ▪ Cole, J.J., Caraco, N.F. 2001. Carbon in catchments: connecting terrestrial carbon losses with aquatic metabolism. Marine & Freshwater Resources, Vol. 52, pp. 101-110 ▪ Richey, J.E., Melack, J.M., Aufdenkampe, A.K., Ballester, V.M., L.L.Hess, L.L., 2002. Outgassing from Amazonian rivers and wetlands as a large tropical source of atmospheric CO2, in Nature, vol. 416, 11 April 2002, p. 617-20 (Luc Gagnon, Hydro-Quebec)	Rejected
4-1725	A	111	1	0	0	References: Kindly make sure that the above cited references are included (Friedrich Plöger, Siemens AG)	Rejected
4-1726	A	111	1	128	0	References need to be checked as some were missing, eg CICERO, (John Kessels, Energy Research Centre of the Netherlands)	Accepted
4-1727	A	111	1	0	0	* Add to reference list: Gan, Lin, Gunnar S. Eskeland and Hans H. Kolshus, 2006. Green electricity market development: lessons from Europe and the U.S.. Energy Policy, (In Press). (Government of Norwegian Pollution Control Authority)	Rejected
4-1728	A	112	44	112	44	Zeland not Zealand ? (Stefano Caserini, Politecnico di Milano)	Rejected
4-1729	A	114	1	114	1	Santosa... : move to pag 124	Rejected

						(Stefano Caserini, Politecnico di Milano)	
4-1730	A	114	5	114	9	The correct citation for the Dooley, et. al. paper is: Dooley, James J.; Dahowski, Robert T.; Davidson, Casie L.; Bachu, S., Gupta, N.; Gale, J. "A CO2 Storage Supply Curve for North America and Its Implications for the Deployment of Carbon Dioxide Capture and Storage Systems." In, ES Rubin, DW Keith and CF Gilboy (Eds.), Greenhouse Gas Control Technologies, Volume I (pp. 593-601). Elsevier Science, 2005. (James Dooley, Battelle)	Accepted
4-1731	A	118	10	118	10	Please replace "IEA 2003h" with "Philibert, Cédric, 2003" (Cédric PHILIBERT, International Energy Agency)	Rejected – information incomplete
4-1732	A	123	37	123	3	Literature is incomplete; it should be: Ragwitz, M; Schleich, J., Huber, C., Resch, G., Faber, Th., Voogt, M.; Coenraads, R., Cleine, H; Bodo, P; (2005): Analyses of the EU renewable energy srouces' evolution up to 2020 (FORRES 2020), Fraunhofer IRB Verlag, ISBN 3-8167-6893-8. (Joachim Schleich, Fraunhofer Institute Systems and Innovation Research)	Accepted