IPCC Fourth Assessment Report

Expert Review of the First-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			The chapter needs substantial improvement. To a very large extent it provides an overview and it is quite difficult to see what is new knowledge (since TAR). Much common knowledge takes up considerable space. Many references state nomore than truisms while in other cases references are misssing for important information provided. There is confusion with regards to the use of the terms 'storage' and 'sequestration' respectively. Another confusing use of terminology is 'capture and separation of CO2'. The authors are recommended to refer to the 'standard' terminology used in the SRCCS. The section on CCS (from fossil fuels and biomass) is generally poor and lacks vital references. (Kenneth Möllersten, Swedish Energy Agency)	Check for 'storage' and ' sequestration' misuse. Also 'capture" and 'separation'. More references on CCS from fossil and biomass
4-2	A	0	0			Since 2002 there have also been increasing instances of eligible plant developments being pushed through against the wishes of all local public authorities, nature and conservation groups - with Inspector's reports from the UK Department of Industry on occasion being the deciding factor despite this adjudication supposedly being in the hands of the Deputy Prime Minister (a quite separate portfolio). One of the most flagrant examples is the wind energy develpement at Romney Marsh. Opposition has increased markedly as 125 m and taller wind turbines have been pushed in locations of high (and officially designated) landscape value and low average wind speed. This has intensified opposition to onshore wind energy developments generally, despite efforts by the authorities to limit the number of turbines (though not, it seems, their size - their definition of scale seems uni-dimensional). Thus the reference to 'not yet able to stimulate new large-scale developments' in the onshore wind context is a consequence of government planning guidance (PPS22 and its Companion Guide). Insufficient effort is being put into stimulating biomass/biofuel developments on any scale. (Michael Jefferson, World Renewable Energy Network/Congresses)	Accepted. Use the Reference listed at end of comment.
4-3	A	0	0			Perhaps one should note that the term "conventional supplies" is quite time bound	Rejected. Classical definition.

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						and that tomorrow's "conventional" energy supply may be quite different than today's. In that regard, I wonder if, when you deal with the various forms of energy and speak of their decline in availability, for example, we should be more explicit about "conventionality". (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	
4-4	A	0	0			It should be specified which heating value basis is used, LHV or HHV, for expressing the thermal energy contents of hydrocarbons. (Takanobu Kosugi, Ritsumeikan University)	Accepted. Add a footnote the first time or put in glossary
4-5	A	0	0			Using USGS as essential data basis is not appropriate to the excellent reputation of IPCC. USGS is known as over-optimistic. Recommendation: use another data source which gives more moderate estimates (between the pessimistic and the USGS estimates). (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Accepted. Serch for other than USGS references.
4-6	A	0	0			The structure of the chapter is inconsistent: All fossil resources are characterised by reserves/production-ratio from the beginning, but the R/P-ratio-approach isn't discussed until page 26 (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Add information available on P 26 line 36 to 40 as a footnote on P 19, line 48.
4-7	A	0	0			The statement "fossil fuels will be available in sufficient amounts for several decades" appears so often that the text gets a certain non-scientific optimistic tendency. This is not acceptable from a scientific point of view. (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Accepted. Text changed..
4-8	A	0	0			The general approach of reserves-production-ratio is outdated and misleading. Examples: Coal lasting for "at least another hundred years" in China (page 16, line 46/47), "total resources available for coal, gas and oil should last for decades under current and anticipated future consumption rates", page 19, line46/47, "...70 years supply at the present rates of consumption." (page 26, line 4/5), and again on page 54, lines 21-26. The report is misleading the reader, because it is NOT a question of how long a resource can last under unrealistic assumptions. The mathematical formula "reserves devided by production = static range" does not match geological	Rejected. R/P is a classical indicator. We adde a sentence warning that consumption will increase and that R/P is just a static measure. What is the usefulness of adding your recommendation?..

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						realities, as e.g. oil cannot be produced at constant rate until the recoverable amount is extracted completely. The geological imperative is: oil extraction is following a bell shaped curve, whether or not a peak is expected or denied. This should be acknowledged in the whole chapter. No matter when (of if at all) the autors expect a peak to happen - please abandon the outdated static-range approach. (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	
4-9	A	0	0			Recommendation: skip all data on static ranges and emphasize the problem of production increases in relation to consumption increases. (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Rejected. R/P is a classical indicator. We adde a sentence warning that consumption will increase and that R/P is just a static measure. What is the usefulness of adding your recommendation?...
4-10	A	0	0	0	0	This chapter should provide some information on the final uses of energy, and the form they take. Information is somewhat scarce but it seems (Jean-Marie Martin, unpublished paper) that about 50% of our final energy needs is of the form of heat (40% as low temperature heat for heating, cooking, water-heating, drying in households and industry, and about 10% as high-temperature heat for industrial processes, and the other half on 'specific' forms (motors, light, etc.)) This may have huge implications on how to use energy efficiently and better match the variety of needs with a variety of resources (ie: heating needs from solar thermal, etc.) (Cédric Philibert, International Energy Agency)	Rejected. Consumption is discussed in other Chapters.
4-11	A	0	0	0	0	This chapter provides interesting materials but fails to put renewables in perspective. It should start by considering the wide gap between curent use of renewable energy sources and their theoretical potential, and assess the role that the main renewable technologies could possibly play in narrowing this gap over this century. Renewable currently accounts for less than 15% of Total primary energy supply, while mankind's total primary energy supply (TPES) was 433 Ej in 2002, including non-commercial biomass, equivalent to a continuous power consumption of 13.75 TW. The IEA projects for 2030 a TPES of about 688 Ej, equivalent to 21.8 TW of power (IEA 2004, World Energy Outlook). This compares to the solar radiation intercepted by the Earth of 173,000 TW, of which 120,000 TW strike the	Accepted. Add comment that renewables use is quite small compared with potential in P 55 on Mitigation costs and potential.

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						Earth's surface. Solar energy is thus the primary energy source on our planet's surface – and exceeds 8,000 times our primary energy supply. Fulfilling global energy needs as projected for 2030 would require covering about 0.6% of emerged lands with 10% net efficient solar conversion systems (Philibert, 2005, The present and future use of solar thermal energy as a primary source of energy, InterAcademy Council). The drawbacks are well-known: the solar radiation reaching the earth is very dilute (only about 1 kWth per square meter), intermittent (available only during day-time), and unequally distributed over the surface of the earth (mostly between 30 north and 30 south latitude). The possible limits to the use of renewables should be discussed in a balanced way: intermittency is an issue for wind and PV, much less for solar thermal and concentrated solar electricity; land occupation is an issue for biomass, given the low conversion efficiency of photosynthesis, much less for others; costs represents an issue, especially for PV, but R&D and learning-by-doing are reducing them while the costs of fossil fuels, or some of them, is likely to increase as they become more scarce and externalities are priced. (Cédric Philibert, International Energy Agency)	
4-12	A	0	0	0	0	The figure 4.4.5 on page 112 is poorly informative. I would suggest replacing it by a scheme from Steinfeld, Aldo and Robert Palumbo, 2001. Solar Thermochemical Process Technology, in R.A. Meyers (ed.), Encyclopedia of Physical Science & Technology, Academic Press, showing the diversity of processes to produce fuels (hydrogen or metals) from concentrated solar energy. It's reproduced on slide 15 in the attached powerpoint presentation. 15: 237-256 (Cédric Philibert, International Energy Agency)	Check Powerpoint presentation delivered. In particular slide 15.
4-13	A	0	0	0	0	Figure 4.1.15 lists 11 possible wedges attributed to Pacala and Socolow. However, the paper indicates 15 possible wedges. Please indicate them all - or none. (Cédric Philibert, International Energy Agency)	Accepted. Better explanation will be added to Figure 4.1.5.
4-14	A	0	0	0	0	Energy statistics must always be presented with some caution and their complexity underscored. With respect to Total primary energy supply, the bulk of the	Agree, but requires a lot of space.Try to add quote kWh of hydro and kWh of nuclear in J

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						contribution from renewables comes from biomass, about 11% of the total, and hydraulics, for 2,7%. However, this biomass is mostly non-commercial, not always really renewable, and mostly used in unefficient manner, so that its contribution to the satisfaction of our energy needs is less than suggested by this percentage. Conversely, hydraulics appears for 2,7% while, say, nuclear appears for about 7%, but the two technologies provided almost exactly the very same quantity of kilowatthours in 2004. The reason for the difference is that TPES accounts for the heat produced in nuclear plants, not only electricity, for this heat could be used - and this is fair when nuclear is to be compared to fossil fuels - but as the result hydraulics (and this would be the same for wind power or PV, but not CSP technologies) is somehow underestimated in TPES statistics. (Cédric Philibert, International Energy Agency)	in a footnote when discussing energy produced.. Normal IEA practice
4-15	A	0	0	0	0	Another indication of the abundance of solar energy is, somewhat paradoxically, the threat of climate change itself. The increases in the atmospheric concentrations of well-mixed greenhouse gases from the pre-industrial to present time result mainly from the combustion of fossil fuels for energy purposes. They entail a marginal increase in the Earth and atmosphere's capacity to trap the sunrays' radiative energy, acting as a gigantic solar collector, called the radiative forcing of climate and estimated to be 2.43 Wm-2±10%, which compares to the averaged continuous amount of solar energy on Earth of about 235 Wm-2. This suggests that solar energy has the potential to help solve the problem it creates. (Cédric Philibert, International Energy Agency)	Noted.
4-16	A	0	0			The higher oil prices experienced in 2005 (and anticipated going forward) are significantly above what most models assume. High oil prices can lead to a shift to more coal, as was probably the case in Chinain 2005 (one of the reasons why China's apparent oil demand stagnated, after high growth the year before). In other words, high oil prices do not necessarily translate into lower emissions (although this might be the case for motor fuel demand). I do not want to speculate on the overall impact, but the IPCC must consider high energy price scenarios that are consistent with the current oil market situation. At least sensitivity analysis would	Partially accepted. State a sentence on recent high oil price. IPCC can't based all its studies assuming prices changes occurred in a limited time framework. It can note the fact of oil price increase and uses it as one of the possible scenario.

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						provide very important information for policymakers. In general, the link between energy security (as an element of sustainable development) and climate policy should receive greater attention, as this is high on the priority list of policymakers and offers great synergy potential. (Anne Arquit Niederberger, Policy Solutions)	
4-17	A	0	0			It's more timely to revise up and refer to IEA"World Energy Outlook 2005" in the context where reference is "World Energy Outlook 2004". In WEO2005, world oil demand growth is downwardly revised reflecting on current soaring crude oil price. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Accepted. Let us use "World Energy Outlook 2005" instead of 2004.
4-18	A	0	0			In general, I think the whole area of energy data and statistics (supply and end-use) availability and comparability is an area where more attention is needed. There is also a need to build the capacity to evaluate the effectiveness of programs and policies to reduce greenhouse gases, ideally deriving international best practice and common protocols. A lack of methodologies is one reason why few energy efficiency projects have been registered under the Clean Development Mechanism, despite their enormous potential. Capacity is also lacking to enforce standards and labeling schemes (even the US EnergyStar program is not based on independent testing to ensure compliance), and there is a need for greater international harmonization, to avoid "dumping" of low-efficiency products on less developed markets. (Anne Arquit Niederberger, Policy Solutions)	Noted.
4-19	A	0	0			Good review of energy options with associated benefits and costs. A review of options that are most suitable for Developing Countries would also be useful, as many are experiencing supply shortages and are likely to go in for high polluting carbon based fuels to meet the shortfall (PMMM 2005). Developed countries should share any clean technologies with the developing countries. (Mohan Munasinghe, Munasinghe Institute for Development (MIND))	Accepted, but high oil price is a recent situation and it can't be used as the general rule for IPCC. It may be one of the scenarios. Thus discuss this issue with care.
4-20	A	0	0			For energy producing countries, particularly Middle East countries, which fiscal planning largely depends on oil and gas revenue, it is important to secure energy demand in order to achieve sustainable economic growth for the future. I propose to	Accepted. Nevertheless, consider in the text that security for energy producing countries deals with smaller population than security

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						also discuss the contents about energy security for energy producing countries,as "security for energy demand", not only about security for energy consuming countries. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	for energy consuming countries. Also, most of the producers are already in reasonable financial health and the expected shift from conventional to renewables will occur slowly, with timing opportunities to oil producers country to search for other opportunities.
4-21	A	0	0			Finally, there needs to be more consideration in the report about mechanisms to finance investments in the energy system, in particular energy end-use. If we want to channel some of the trillions of dollars estimated to be needed to in invest in energy infrastructure over the next 25 years to energy saving, policymakers need to find ways to enable the end-users (or intermediaries, such as utilities or ESCOs) to finance them (e.g., public benefits charges, incentive programs, tariff legislation). (Anne Arquit Niederberger, Policy Solutions)	Search if there is room to discuss end-use energy policies. Energy use is discussed in other Chapters.
4-22	A	0	0			Chinese officials recently revised the country's GDP figure for 2004 upward to 16,8% (double the previous value), and the numbers will be revised for years back to 1993. As a key driver for CO2 emissions, this change needs to be acknowledged in the report and its significance for the scenarios and data presented must be discussed. (Anne Arquit Niederberger, Policy Solutions)	Check if energy versusGNP discussion can accommodated the China example.
4-23	A	0	0			It would be useful to have a roadmap of the breakdown of sectors either in Chapter 4 or Chapter 1. A figure on how the various topics are divided between sectors would be helpful. (Haroon Kheshgi, ExoonMobil Research and Engineering Company)	Accepted. Improves text and discuss if figure shall be in Chapter 4 or 1.
4-24	A	0	0	0	0	The chapter should be shortened. A lot of description of technologies can be reduced, the aim is to indicate the mitigation options (Monique Hoogwijk, Ecofys)	Accepted. The text is 40% larger than allowed.
4-25	A	0	0			electricity production -> electricity generation REASON: "generation" is the commonly used word rather than "production" in this context. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted. Use electricity generation.

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4-26	A	0	0			Chapter 4, when discussing bioenergy from plantations, should treat constraints and opportunities linked to water. For example, Berndes (2002) reports that a large-scale expansion of energy crop production would lead to a large increase in evapotranspiration appropriation for human uses, potentially as large as the present evapotranspiration from global cropland. More recently, Jackson et al (2005), looking at tree plantations for C sequestration, report that the increased evapotranspiration resulting from establishment of plantations can lead to substantially reduced stream flow and also lead to increased soil salinization and acidification. Thus, in some countries, a large scale expansion of bioenergy plantations could lead to further enhancement of an already stressed water situation. But there are also countries where such impacts are less likely to occur. Re: benefits, opportunities linked to plantations as vegetation filters have been mentioned above. Generally, plantations can help control groundwater recharge and upwelling. References on bioenergy-water links: (i) Berndes, G. (2002), Bioenergy and water -the implications of large-scale bioenergy production for water use and supply. Global Environmental Change 12(4):7-25.; (ii) Jackson, R. B., Jobbágy, E. G., Avissar, R., Roy, S. B., Barrett, D. J., Cook, C. W., Farlet, K. A., le Maitre, D. C., McCarl, B. A. and Murray, B. C. (2005), Trading water for carbon with biological carbon sequestration. Science, 310, 1944-1947. (Göran Berndes, Chalmers University of Technology)	Accepted. Check the listed literature and let us add a paragraph on this important issue, never before discussed in IPCC. Considerations about water availability to grow biomas are usually considered mainly by relying in rainfed agricultural areas. Nevertheless, this comments deals with a more basic point that is change in water flow due excessive evapotranspiration due large biomass planted areas. This may have little impact for rainfed agriculture but may impact irrigated food production.. Check possible available literature.
4-27	A	0	0	0	0	Chapter 4 should cover the mitigation options within refineries (efficiency improvements) this is not covered in Chapter 7. (Monique Hoogwijk, Ecofys)	Accepted. Discuss with Chapter 7 to define responsibility to add this material.
4-28	A	0	0			The section concerning nuclear energy seems to be taken without question from a very few sources. Some data are based on assumptions, which have been proved to be fallacious. Other data, important in the context of climate change and societal sustainability are missing. As a scientific report AR4 should sharply distinguish between facts and data that are verifiable and those that are not. Hypothetical concepts should be clearly presented as such. Only proven technologies may be presented as being available	Check the level of discussion on Nuclear energy. The complain deals with favourable image of Nuclear Reactors and absence of comments on risks involved. Discussion on safety and environmental issues will be added. See later responses

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						'on the shelf'. One of the inherent problems with assessment of civil applications of nuclear energy is the complexity of the system. Only a few information sources are available, of which at least two are interest organisations: IAEA (International Atomic Energy Agency) and WNA (World Nuclear Association, formerly The Uranium Institute). Both phenomena, the small number of information sources and their questionable independence, have lead to scientific imbalance in AR4 regarding nuclear energy. The reader of this report may erroneously get the impression that the potential of uranium as resource for future large-scale energy generation is practically inexhaustible. Inherent drawbacks of the nuclear energy system and the dangers nuclear energy poses to environment, health and societal stabiliy are hardly mentioned. Mitigation of the adversal effects, particularly activities needed to isolate highly radioactive materials from the biosphere indefinitely, is indefinitely postponed to the future. This stance is based on technical concepts which have proved to be unfeasible. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	
4-29	A	0	0			The chapter should assess whether assuming that economic growth necessarily increases GHG emissions is still valid a valid hypothesis or whether it is no longer a meaningful assumption. Literature exists on this topic (Dunkerley J, 2006; G. Mueller et al, 2004 for instance) but this is not reflected in the IPCC assessment. However, testing this hypothesis is of paramount importance in policy discussions especially for developing countries. (Philippe Tulkens, TERI School of Advanced Studies)	Rejected. Figures presented regardinf GHG emission trends show GHG emissions are growing. In transportation sector no significant change in rate of growth, in the last 30 years, has been noted. Agricultural sector is growing.
4-30	A	0	0			What degree has the chapter taken into account energy infrastructure and what is going to be put in internationally by utilities. Clive did say yes it was an important issue about replacing aging power infrastructure. (Capetown Industry Expert Meeting, Industry)	Accepted. Try to discuss better the future infrastructure for energy production and what will be expected from large companies.
4-31	A	0	0			Some of the figures too complex and too confusing. PV and ethanol do not make sense together with no single message being conveyed.	Rejected. Ethanol and PV can be together in the same figure sinceit deals with learning

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						(Capetown Industry Expert Meeting, Industry)	curve. Add to the y-axis the world 'ethanol'.
4-32	A	0	0			Robert Chase suggested that hydropower was stated as a low emission source, is there is means of the IPCC process to ensure consistency as in WG II there is a debate on the science on wetlands and hydro which could make hydro equivalent to coal fired power stations. (Capetown Industry Expert Meeting, Industry)	Rejected. No space to extend discussion. It has been verified that in average hydros emit at least one order of magnitude less GHGs than fossil fuel based plants, when generating the same amount of electricity.
4-33	A	0	0			No balance in the chapter regarding rule of law, equity that companies can not address fully with Govt more responsible. (Capetown Industry Expert Meeting, Industry)	Check proper discussion on equity and how private sector can deal with it. Check P 76 to 77, mainly 77, lines9 to 19.
4-34	A	0	0			Lenny Bernstein added that tar sands are commercial today and projected to grow in the use in the next decade. Coal bed methane also there are significant programmes in the US. Methane hydrates was not mentioned in the chapter at all. Chapter has not reflected this options in the chapter. Language in the chapter about the impacts and problems from the fossil fuel energy in developing countries, for example gas flaring is equivalent use of france and beligum put together. This is a waste but there is an active programme to eliminate flaring. Needs to be more clearly mentioned in the chapter. (Capetown Industry Expert Meeting, Industry)	Accepted. More on unconventional energy sources is being added. Add a sentence on gas flaring reduction program. Regarding methane hydrates see P 23, line 36 up to 39.
4-35	A	0	0			Increase in biomass taking vital feedstock from the chemical industry is not reflected in the chapter? (Capetown Industry Expert Meeting, Industry)	Not relevant. Small share of the energy market. If space allows add one sentence.
4-36	A	0	0			Concern about the potential of other technologies and the very little assessment on the economics in this chapter. What about technology transfer where it is addressed in the chapter? Key issue is governments are the ones that facilitate technology transfer but do not own the IPR for those technologies needs to be reflected. (Capetown Industry Expert Meeting, Industry)	Accepted first sentence. We are improving cost evaluations for mitigation. T. Transfer accessed at P82..
4-37	A	0	0	0	0	□ Third, the paragraph dealing with health and environment concerning energy should refer more to an analysis of impacts of power generation means. At the	Accepted. Change discussion from incidents to available information on external costs.

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						moment, it summarizes a list of incidents that have happened all around the world and this is not satisfying at all because there is a lack of structure. The ExternE methodology referenced in my specific comments uses the impact pathways methodology and has assessed impacts of different power generation technologies. After that valuation methods lead to the assessment of external costs. Results are expressed concerning different areas from local to regional and finally global level and different timeframes (short term to medium term and long term impacts). Other countries like US have provided similar methodology, but the European one is the last one and is constantly updated and improved through research programs (easily available on the web, NEEDS program for example or CAFÉ-Clean Air for Europe). (Nicole DELLERO, Corporate Strategy AREVA)	More reference to ExternE.
4-38	A	0	0	0	0	Secondly, I think that as concerns nuclear and in view of review by NGOs the issues of waste management and safety should be highlighted based on facts. A description of general policies for waste management all around the world should be given including low, medium and high level wastes. Progress in these policies is interesting. As concern safety, it is important to explicit the concept of defense in depth and the type of measures considered at engineering and operating level to maintain reactor safety. (Nicole DELLERO, Corporate Strategy AREVA)	Taken into account Waste management: it is not possible within the allotted text space to go further into details. Short discussion of safety & environmental impacts will be added. Check if something relevant occurred since TAR regarding risks reduction associated with the use of Nuclear Energy.
4-39	A	0	0	0	0	Fourth, publications exist as concern Life cycle analysis of power generation technologies and I can give different scientific references on request by the lead authors. Remember that the European utility Vattenfall has implemented internally such study and has published reports including life cycle assessment results. (Nicole DELLERO, Corporate Strategy AREVA)	Ask Reviewer for LCA reports available.
4-40	A	0	0	0	0	First, I have observed that as industrial sources British Petroleum, especially in the Energy supply chapter is often cited but there are other industrial sources of information. In fact BP has not legitimacy all the time to assert the figures and ideas and some other oil companies should be referenced. As concern general energy and nuclear, I have provided different sources in that way in my specific	Noted More relevant to other sources than nuclear. Accepted. Be careful when using BP data. Nevertheless, historical information looks reliable. TAR used mainly academic studies

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						comments. IPCC should equilibrate the origin of business sources and should prefer conference papers presented in high level dedicated business conferences (Nicole DELLERO, Corporate Strategy AREVA)	for information. Try to make a balance from different sources of information.
4-41	A	0	0			In trying to capture the scale of reigning in energy-sector emissions, one possible graphic is that of "population vs per-capita emissions" in different regions, which encapsulates several dimensions of the challenge including current inequalities, potential for future growth, relative scales of industrialised and developing country contributions, and divergence within each group. The most recent version of the graphic is published in M.Grubb, "Kyoto and the Future of International Climate Change Responses: From Here to Where?", International Review for Environmental Strategies, Vol. 5, No. 1. But if the authors are interested I could supply the data and package for generating the graphic, with or without attribution. (Michael Grubb, (a) Carbon Trust(b) Cambridge University(c) Imperial College London)	Noted. It is a well known and accepted issue. No space for more figures. More appropriate for Chapter 1 or 2..
4-42	A	0	0			This chapter could give more information on the costs and cost effectiveness of the energy saving options and emission mitigations measures, e.g. by technologies, sectors etc. (Ilkka Savolainen, Technical Research Centre of Finland VTT)	Accepted. We are improving information on costs.
4-43	A	0	0			The emission reduction cost is given often in dollars per tonne of carbon. I would express the costs per tonne of CO2 which is a common practice e.g. in the EU ETS and in many other activities. (Ilkka Savolainen, Technical Research Centre of Finland VTT)	Accepted. The report will present figures in $ per tCO2.
4-44	A	0	0			Chapter 4 deals with one of the most important topics (arguably the most important topic) related to mitigation: energy supply. It is a very long Chapter, jam packed with all sorts of information. It is a daunting task for the reader to sift through the material, and I was often led to ask myself how the chapter could be structurally improved. My only thought is that it might have helped if the chapter had been structured around the question of how far carbon-free energies might be able to go in this century toward displacing fossil fuels. Attempting to answer that question might help address a related question: how much will we have to rely on carbon	Agrre. Structure is being changed and it will be shortened. Regarding CCS we will base our discussion on the concept of wadges (Paccala and Socolov, 2005). Most of the comments already addressed through specific comments.

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						capture and storage (CCS) if we are to get on to an acceptable stabilization path over the course of the next several decades? Having said this I wish to focus on a number of specific points, almost all related to the Report's treatment of renewable energies, in particular solar, wind and biomass energies. Before taking up a number of concerns that I have with the Report's treatment of renewables, I think it instructive to quote two statements made about the role and importance of energy. These important statements appear on pp.67 (lines 45-50) and 68 ((lines 10-15). Let me quote in part (and also suggest that they might be better placed at the beginning of the chapter. "Energy services are fundamental requirements to achieve sustainable development [emphasis added]. Energy provides comfort, convenience, and mobility; enables labour productivity and information access; and, along with human resources drives the development process." (Ch 4, p.67, lines 45-47) "Historically, economic growth of 1 % per capita in a developing country has been associated with an increase in the consumption of electricity of 1.3 to 2 % per capita. Combined with population growth and massive economic inequities in many developing areas, this translates into a daunting requirement for additional energy supplies in order to support sustainable development" [emphasis added] (Ch. 4 p.68, lines 7-10). (Christopher Green, McGill University)	
4-45	A	0	0			With 107+37 = 144 pages (text + figures/tables), Chapter 4 is well above max. page allocation (120) (Ad Seebregts, Energy research Centre of the Netherlands)	Noted. It will be reduced.
4-46	A	0	0			This IPCC report should be an essential work to bring some sense to the energy debate in the world and move rapidly towards decarbonisation. We will all agree that the IPCC AR cannot afford a weak Energy chapter. But I find this chapter very, very weak in its present form. In scientific debates you do not need many mistakes to loose credibility but when you loose it, you loose it almost completly. Some important sections of this chapter are of high quality already and some others acceptable for a zero order draft. But many others, no less than 1/3, (including many paragraphs in the Executive Summary¡) are really disappointing in quality (	Thanks for the evaluation. We are changing the Chapter structure, reducing the text size and improving the discussion based in specific comments received..

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						incomplete, wordy, selective with the references to fit the author's view and, in some cases, plainly wrong). There are some very policy-relevant issues on the energy debate superficially treated (for example: the notion that fossil energy is so dominant today because it receives governments subsidies, the notion that any problem can be solved with sufficient R&D funding , the glossy view of all renewable energy forms of energy, the notion that clean energy systems are not penetrating the market just because the resistance of large corporations.....). I think some authors have not left behind their political believes. They should focus on facts and numbers (including always the critical issue of cost) and use all the peer reviewed literature (inluding papers reporting data against their view¡). They should make use of plenty of space (that can be gained deleting lots of trivial text elsewhere) to support more carefully their boldest statements (like statements on today´s large subsidies for fossil energy and little for renewables, which is extremely policy-relevant if proven true). Large differences in the quality of the text are present even inside the same subsedction. Therefore I feel that this draft has lacked scientific debate among members of the author team and big changes are to be expected. My hope is that the quality, the sense and the balance that some authors have shown already in some parts of this draft, can be extended to the whole chapter in a future draft, against those that have shown strong emotional prejudices or unjustified preferences while writing their text (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	
4-47	A	0	0			This chapter is very comprehensive, describing current status, future trends very well. The chapter becomes very speculative and not based on sound literature in the subsection 4.7.4.2 "Equity and Shared Responsibility." I will provide more specific comments below. There are also other passages in Chapter 4 that border on policy prescritpiveness rather than assessing policy relevant facts. I will comment on those below also. (Arthur Lee, Chevron Corporation)	Thanks. Section 4.7.4.2 is being deeply revised. We will lok for your further specific comments..
4-48	A	0	0			General comment: Chapter 4 is well-written summary of energy supply issues. (Sanna Syri, VTT)	Thanks.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-49	A	0	0			'DJ' comments are from Daniel Jansen (Ad Seebregts, Energy research Centre of the Netherlands)	Thanks.
4-50	A	0	0			DJ Avoid the word sequestration in the context of CO2 capture and storage, So use CO2 capture and storage and not CO2 capture and sequestration (Ad Seebregts, Energy research Centre of the Netherlands)	Use proper terminology from SRCCS. Check 'sequestration' word used in text
4-51	A	0	0			Avoid the word sequestration in the context of CO2 capture and storage, So use CO2 capture and storage and not CO2 capture and sequestration (Daniel Jansen, Energy research Institute of the Netherlands)	The same as above.
4-52	A	0	0			While this chapter contains a great deal of valuable analysis and information, most unfortunately there must be huge reservations about its capacity to generate solutions to the fundamental problem. This is simply because most of the analysis and information appears to be almost totally based on, and----even more unfortunately---oriented at, an assumption of business as usual. (Pat Finnegan, Grian)	Thanks for the evaluation. We are changing the Chapter structure, reducing the text size and improving the discussion based in specific comments received...
4-53	A	0	0			The key message of this chapter should be whether it is possible to meet rapidly growing global energy demand while dramatically reducing the CO2 emissions from energy supply and use, and if so how. There is obviously a lot of work behind this chapter, and the various elements of a required energy path are covered. (There are also a lot of assertions that this reviewer would take issue with.) But a realistic key message does not come through. The emphasis on various issues in the chapter seems out of line with the nature and scale of the problem -- e.g. one would have expected the chapter to deal with the challenges of transforming the energy systems of the US, China and India, each with heavy dependence on coal rather than worrying about the use of coal in place of wood in rural Niger. Mainstream projections of global primary energy supply such as the IEA's make it clear that global energy needs will maintain and increase the reliance on coal, oil and natural gas. The discussion of global energy supply should deal primarily (though not exclusively) with this reality and the challenges of advancing and deploying CO2 capture and sequestation in key countires (esp China and India) on an accelerating scale. An excellent reference in this regard is Sustainable Fossil Fuels, Cambridge	Thanks for the evaluation. We are changing the Chapter structure, reducing the text size and improving the discussion based in specific comments received.. During redraft remember that the key message of this chapter should be whether it is possible to meet rapidly growing global energy demand while dramatically reducing the CO2 emissions from energy supply and use, and if so how.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						Univ Press, 2005 by Mark Jaccard (jaccard@sfu.ca) (Richard Hyndman, Canadian Association of Petroleum Producers)	
4-54	A	0	0			I am very concerned that the focus of Chapters 4 is predominantly on the next 50 years, and subdominantly on the remainder of this century. The reality illustrated by the analysis of Wigley, Richels and Edmonds, and similar analyses provided for example on pages 223-224 of the TAR Climate Change 2001, The Scientific Basis, BUT IGNORED HERE, is that the problem is much longer term than this. Furthermore, the problem is 10x larger in the long term (~50,000 EJ / 50 years) than in the short term (~5000 EJ / 50 years). As part of the resolution of this problem, we need to introduce technologies in the present century that can almost fully replace carbon-emitting technologies in the next century. Thus we need to be advancing new energy technologies with very high total potential, and we need to be moving to energy uses that are consistent with very low CO2 emission. While it is important to pay attention to the near term, this report must absolutely also keep the much larger long term challenge in focus. See the attached analysis of future non-carbon energy needs, labeled "WRE Analysis.pdf". (Robert Goldston, Princeton Plasma Physics Laboratory)	Regarding horizon the full report should consider short term as 2030 and long term as 2050. We have to note that most of the implementation of these new technologies will occur after 2050.
4-55	A	0	0			Due to the non-sequential numbering of the table and figure pages in Chapter 4, this comment is provided both as an overall Chapter 4 comment (here) and as a comment at the insertion point of Table 4.5.3. ----- Table 4.5.3 should include a column "Technical potential up to 2200" since climate change is a much longer-term problem than just the next 50 years. It should then also include a row for fusion. The row for fusion could read: Energy resource: Fusion / Current approximate use (EJ/yr): 0 / Technical potential up to 2050 (EJ): 10 / Technical potential up to 2150: 300,000 (land) 5x10^9 (ocean) / Inherent carbon: **** / Consumer costs (2005) $US: 5 - 10 c/kWh(e) / Projected investement costs in 2050: 3 / References: J. Sheffield et al. "A Study of Options for the Deployment of Large Fusion Power Plants", Fusion Science and Technology, 40, p. 1-36, (2001) ---- [Note that it has been assumed for all of the depletable energy sources that it is technically possible to burn all of their fuel resources in 50 years. This is false - for	Rejected. Mandate select 100 years horizon...

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						example a breeder reactor requires a long time to breed the fuel to start another breeder reactor.] (Robert Goldston, Princeton Plasma Physics Laboratory)	
4-56	A	0	0			The structure of Chapter 4 is not very clear and the purpose of each section is not always clearly stated. Additional links between the sections should be made. Please see further constructive comments below. (Peter Wittoeck, Belgian Federal Administration)	Accepted. Chapter is being restructured.
4-57	A	0	0			electricity production -> electricity generation REASON: "generation" is the commonly used word rather than "production" in this context. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted. Use electricity generation.
4-58	A	0	0			Chapter 4 provides figures for a.o. (i) total life-cycle GHG emissions per unit of electricity produced by alternative sources (with a comment related to nuclear and renewable energies on page 32) and (ii) the costs of electricity production. Although they are much debated in the literature, methodologies used for the computations of these figures are neither presented nor discussed (probably due to limited space). Moreover, these figures are based on very few references (with only one reference for (i)). We suggest that, at least, additional references be given for the figures in order to support them (or additional figures be included). (See also comments below.) (Peter Wittoeck, Belgian Federal Administration)	Accepted Limited text space does not allow thorough discussion of methodologies. The reference for LCA itself is a recent review and contains many references to previous LCA-studies. A few additional references could be added. Try to add more references when discussing cost of electricity generation. Also, references provided by reviwer welcome..
4-59	A	0	0			Graphs and text do not always match (Antoine BONDUELLE, E&E_Consultant)	Editorial issue. It will be corrected.
4-60	A	0	0			This chapter gives lot of inormation but as yet lacks 'big picture' insights about the implications, and yet I think such a theme is available. The TAR noted that the global energy system has to undergo major transformation anyway during the 21st Century, in part because of resource constraints on the fuels that came to dominate the 20th century (conventional oil and latterly gas). Should not the chapter be framed around the question of the possible natures of the trajectory of the energy system, and the implications of that trajectory for CO2 emissions and the	Describe big picture in Executive Summary and include mitigation cost and potential..Bill and Ralph.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						implications of policy choices for the nature of the trajectory? There is far too much space taken by statement of (I think well known) facts, and not nearly enough insights or developments since the TAR. (Michael Grubb, Cambridge University)	
4-61	A	0	0			There is an overview of the results presented on the TAR, but you don't find it in other chapters, so the reader is confused about the general strategy of the text (Marco Mazzotti, Institute of Process Engineering)	Check with Bert. Looks like we are doing right and the other chapters not.
4-62	A	0	0			The presentation at length of each energy source (fossil, nuclear, hydro, other renewable) is rich, well balanced on advantages and disadvantages of each source, with no particular bias in favour or against one source, and well informed, taking a wide range of recent information into account (including IEA and WEC reports). (Jean-Yves CANEILL, Electricité de France)	Thanks for highlighting discussion on energy sources.
4-63	A	0	0			One major comment from the development angle relates to the co-benefits of mitigation policies and actions. This is raised in Chapters 3, 4, and 11, and Chapter 4.7.3 para 20 even currently notes: The variety of co-benefits stemming from utilization of new energy technologies, the dynamics of innovation and mitigation, and other non-climate policies should be understood as an essential part of economic policies striving for sustainable development at the local, regional, national and international levels. The co-benefits described are generally framed only in terms of the direct impacts of cleaner energy or energy efficiency (such as air pollution and health impacts). I'd certainly like to see greater attention to these, especially as their valuation can hold sway in decision-making, and hope that they will be taken up further in the Adaptation-mitigation linkages chapter of WGII. However, there is an absence of a rising body of evidence to suggest that there are further more indirect developmental benefits that can be gained through pursuit of mitigation solutions. In fact it may be that these goals may be pursued in their own	Accepted. Try to include GHG mitigation co-benefits in more areas than essentially air pollution and health impacts. As example decentralized energy can impact poverty reduction. Address this comment to Chapter 2.. Add references provided in Renewable Energy

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						right and the incidental benefit would be to reduce emissions – ie development driven rather than climate change driven (WWF, 2004) The decentralised energy literature has always been well-linked in with the climate change issue, but the focus still tends to be on efficiency-gains (cf. Global Village Energy Partnership; WADE, 2005). Despite some examination of the impacts of decentralised energy on poverty reduction (eg Johansson and Goldemberg, 2002; Practical Action, 2005), I feel the IPCC is well-placed to highlight the role that decentralised and non-grid-based networks can play in reducing vulnerability to climate change impacts. Firstly, there are studies that illustrate how introduction of decentralized renewable energy can stabilize the ecological and social determinants of climate change vulnerability, as well as helping mitigate emissions (eg. Venema and Cisse, 2004: pages 3-29). In addition, a case has been made that there are 'democracy' gains through increased participation in decision-making processes, self-determination (WWF, 2004). It would be good if these broader elements of the debate could also be reflected in both the sustainable development framework set out in Chapter 2, and in the operational chapters 4 and 11. References: Global Village Energy Partnership http://www.gvep.org/ Johansson, T.B and Goldemberg, J (eds.) 2002 Energy for Sustainable Development: A Policy Agenda. UNDP, New York. Our Power and WWF (2004) From Free Markets to Our Power: A new reform paradigm for the power sector in developing countries? Discussion Paper December 2004, Our Power – WWF Practical Action (2005) Europe's chance to help light up Africa: Energising poverty reduction in Africa Intermediate Technology Development Group, Rugby, UK. WADE (2005) World Survey of Decentralized Energy. World Alliance on Decentralised Energy, Edinburgh, UK. Venema HD and Cisse M (eds) (2004) Seeing the Light: Adapting to climate change with decentralized renewable energy in developing countries. IISD, Canada	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Thomas Tanner, Institute of Development Studies)	
4-64	A	0	0			Authors for sections 4.5 onwards may find some useful additional material in several of the individual papers of the Innovation Modeling Comparison Project (for Synthesis see Edenhofer et al. Edenhofer, O., et al. (2006). "Induced Technological Change: Exploring its Implications for the Economics of Atmospheric Stabilization." Energy Journal (Special Issue: Endogenous Technological Change and the Economics of Atmospheric Stabilization), forthcoming 2006. (Michael Grubb, Cambridge University)	Accepted. Investigate suggested literature for sections 4.5 and the following ones.
4-65	A	0	0			Access to energy will be a key for future developments. Referring to my comments fro Ch.12, I would suggest to incorporate WBCSD's A Quartet (Access, Affordable, Acceptable energy with Adequate returns for the investors) as a way of structuring the information. The Chapter covers a number of interesting aspects and is well written. However, I would like to see the following taken even further: 1) The regional development trends will lead to different emissions profiles and different redustion options for the regions. If coupled with the A Quartet, this could provide new insight simply by the way the material is structured. 2) The value chain (LCA) assessments could have been more emphasized, both related to costs and emissions. (Oren Kjell, Norsk Hydro ASA)	Interesting. Can the reviewer provid valid reference on the A quartet.
4-66	A	0	0			Report should mention the global carbon emmissions which would rsulty in no increase in atmospheric CO2. (Steven Freedman, Energy Consultant)	Addressed to Chapter 3.
4-67	A	0	0			Omits mention of using energy in a smarfter manner. Fluorescent and sodium vapor lights use energy in a much more efficient manner than incandescent lights, which in turn are more efficient than gas light which are more efficient than kerosene lights,etc. Gas turbine combined cycles are more efficient than steam turbines which are more efficient than reciprocating steam engines, etc. Summary should raise the issue of using new and known technology such that the same end use energy services are provided at appreciably lower carbon emissions price.	Address to Chapters dealing with end-use (Chapter 5, 6,7, etc). Regarding cogeneration we discussed the issue.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Steven Freedman, Energy Consultant)	
4-68	A	0	0			Equation for global carbon emissions avoids inclusion of a term for nation population, theby giving the illusion that global warming is not related to population growth. Please modify to include national population and emissions per capita. (Steven Freedman, Energy Consultant)	Check if population increase isn't proper refereed in text when discussing equation for global carbon emissions.
4-69	A	0	0			This chapter has a major structural problem. The material on mitigation options is now spread over 3 sections (4.3-4.5) in such a way that no coherent picture of the mitigation options, their potential and costs emerges. Bits and pieces are scattered over various sections, internmigled witth text that belongs to 4.2 (on trends in the energy sector). A major restructuring is required around the mitigation options (that is what this chapter is about). For instance by treating the various electricity options systematically (coal- coal quality, better PC, better IGCC, cogeneration, CCS-; gas -various options, incl CCS-; wind, biomass, solar pv, solar thermal, nuclear. Also options in energy transformation, etc. For all options discuss technologies, maturity of these technolgies (see IPCC SRCCS), potential, cost together and present summary/ overview table at the end. This is essential to turn this chapter into something useful. In the policy section (4.6 and 4.7) many elements are found on energy security and trends in the energy sector that belong in 4.2. Focus on 2030 for the numbers (with extrapolation to 2050 where possible). (Bert Metz, IPCC)	The Kaya identity allows you to add any factor. But we don't need explicitly population accounting for the particular discussion..
4-70	A	0	0			CCS= CO2 capture and storage (see IPCC Special Report) (Bert Metz, IPCC)	Accepted.
4-71	A	1	25	1	25	Nuclear fusion is very different from nuclear fission in ways of importance to this analysis, so it should be allotted its own section, particularly in light of the large international investment in ITER. Fission could be 4.3.2.1 and Fusion 4.3.2.2.Text for such a section is provided in an attachment labeled "Fusion Energy.doc". Also Fossil energy should be section 4.3.1 and its subsections. This could be achieved by collapsing section 4.3.1 into 4.3. (Robert Goldston, Princeton Plasma Physics Laboratory)	Noted; cf. similar comments for section 4.3.2 Check possibility for special heading for Fusion.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-72	A	1	41			page 1, 41: "...Recent liberalization of energy markets in many countries has led to energy supply security and affordability of energy services..." I wouldn´t sign this - liberalization in the first phase resulted in market penetration and - just in the first few year decreasing prices. Since liberalization, the overall investment in new power plants and the (maintenance) of grids dropped significantly (Arjette Stevens, De Koepel)	Accepted. State positive and negative facts associated with privatization.
4-95	A	3	0	5		This is NOT a summary of the Chapter. I would like to see more quantitative information, balanced statements and pieces of text clearly supported by the corresponded sections in the Chapter. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Being rewritten
4-96	A	3	0			Table 4.3.1 comment: We have concerns in the column Estimated Available Energy Resource - please see attached email from Elizabeth Brown. (Stan Bull, National Renewable Energy Laboratory)	Being recompiled. BOB
4-97	A	3	0			Table 4.3.1 - "Cost when located on a good site" for wind says 4-8c/kwh, yet in the text (ch 4, p 55, l50) says 3-4c/kwh for a good site. Should be consistent. Also, showing solar as 25-160c/kwh seems an extreme range for today's technology; 20-30 c/kwh seems more appropriate, and 30 c/kwh is qutoed on ch 4, p 57, l 19. seems more accurate from our knowledge. Lastly, there seems little point in mentioning "bird kills" in the table unless the author chooses to expound on the minor and local nature of these issues in the text, which he did not. For a recent study of PV costs, see any of the following (full report, exec summary, presentation summary): http://eetd.lbl.gov/ea/ems/reports/59282.pdf http://eetd.lbl.gov/ea/ems/reports/59282-es.pdf http://eetd.lbl.gov/ea/ems/reports/CA_PV_Analysis.pdf (Stan Bull, National Renewable Energy Laboratory)	Accept. Ralph
4-98	A	3	0			Many cells of this table are incomplete,markedwith ?, and need further elaboration.	Being completed.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Muhammad Latif, Pakistan Atomic Energy Commission)	
4-99	A	3	0	4		The Executive Summary lists quite a few historical facts and generalisation but somehow lacks punch in terms of concrete findings. In addition, language such as "It is vitally important…. " and "There is a criticial need" doesnt seem appropriate to IPCC. What the assessment needs to communicate are insights about the nature of the problem, options and their implications. (Michael Grubb, Cambridge University)	Being written. Agree
4-100	A	3	0			Table 4.3.1 - There might be a misprint on table 4.3.1: contrary to the economics of oil or gas resource, the impact of "costly" Uranium resource (US$ 130/kg) on the full cost of nuclear plant is quite minimal (less than US$ 0.3 cents/kWh). (Jean-Yves CANEILL, Electricité de France)	Accepted; one should clarify which figures apply fuel costs and which total costs. One could also refer to the OECD cost comparison.
4-101	A	3	0	3		Table 4.3.1. It's not entirely clear what the cost ranges represent. Are these current costs at the best sites or does it also include projected costs including technology learning and increases in fossil fuel prices over the long-term? I would suggest including both--one column showing a current cost range and a second showing projections of future costs. I would also suggest including electric generation costs for coal, gas, and oil, in addition to fuel costs, to make them more comparable to nuclear and renewables. Ideally, this would include different technologies such as a conventional coal and gas plant without CCS and an advanced coal or gas IGCC plant with and without CCS. The low end of the range for nuclear costs is also completely unrealistic. Data from DOE/EIA show costs for a new advanced nuclear plant of 6-7 c/kWh (See, EIA, Annual Energy Outlook 2005, Issues section). (Steve Clemmer, Union of Concerned Scientists)	Accepted; see response to comment 4-100
4-102	A	3	0	3		Table 4.3.1 The cost ranges for wind, solar PV, and solar thermal are reasonable based on today's costs, but are considerable higher than what is expected in the future. DOEs National Renewable Energy Laboratory projects wind costs to	Being reviewed

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						decline to ~2.5-3 cents/kWh in 2025 at good sites, and solar PV and solar thermal costs to decline to ~5 c/kWh in 2025. (Source: http://www.nrel.gov/analysis/docs/cost_curves_2005.ppt). The low end of the range for biomass should be more like 2.5 c/kWh for biomass cofiring in existing coal plants and low fuel costs. (Steve Clemmer, Union of Concerned Scientists)	
4-103	A	3	0	3		Table 4.3.1 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)	Noted Possibility of referring to external cost studies (e.g. ExternE-studies of EU) will be considered as a substitute or as an additional column.
4-73	A	3	2			Section: Executive summary. I'm not very impressed by the executive summary. I feel that key messages are missing and that the oveall strength of the message on energy supply is not very convincing. For instance, the question of decoupling growth from carbon emission is not addressed. (Philippe Tulkens, TERI School of Advanced Studies)	Criticism on Executive Summary. Includes decoupling energy use from economic growth there.
4-74	A	3	4	3	6	What is the basis for this very dramatic statement? As I read through chapter 4, the tone is not necessarily that dire. However, the tone is very dire, stating: "The existing global energy system is no longer capable of supporting economic activity, providing security of supply, and maintaining human well-being within an acceptable resource budget ..." I recommend toning down such a melodramatic statement with the following sentence, which would be more consistent with the facts and trends: "The existing global energy system is facing multiple challenges in supporting economic activity, providing security of supply, and maintaining human well-being with an acceptable resource budget, without imposing significant	Acceped. Change sentence by the reviewer suggestion.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						impacts on the environment." (Arthur Lee, Chevron Corporation)	
4-75	A	3	4	3	25	Delete the first 3 paragraphs because they are too broad and loose. The third paragraph, in particular, sounds really weak, with softy, patronizing, political sentences like "Extraction and consumption will need to be replaced by envioronmebntal stewardship" or "this evolution will require long term vision and leadership". The problem is that this kind of wording appears in many places all over the Ex Sumamry and the Chapter . Keep to facts and figures, scientific and technical information as the IPCC guidelines request . (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Noted. Being rewritten
4-76	A	3	4	3	33	Suggest that this section of the ES be deleted. It is in several places unclear and seemingly contradictory. This is in contrast to the latter part of the ES which seems more connected with the underlying chapter. (Haroon Kheshgi, ExoonMobil Research and Engineering Company)	Being re written
4-77	A	3	4	3	6	It is unclear what is meant by the strong statement that "the existing global energy system is no longer capable of supporting economic activity"? The statement should be clarified (eg "no longer": when did this switch from being capable to support economies to not being able?) and supported by some section of the underlying text in detail. (Haroon Kheshgi, ExoonMobil Research and Engineering Company)	Noted
4-78	A	3	4	3	6	This sentence is a bit too subjective (Monique Hoogwijk, Ecofys)	Agree
4-79	A	3	4	5	3	The chapter should deal with the mitigation options in the energy supply sector. This is not refelected in the executive summary (Monique Hoogwijk, Ecofys)	Being rewritten
4-80	A	3	4	3	4	TABLE 4.3.1.; I have several questions regarding thios Table: 1) whats the difference between Table 4.3.1. and Table 4.5.3? 2) Why not split biomass in different feedstock or different energy carriers, huge difference; 3) at environmental impacts, land use is missing, non-CO2 GHG emisisons are missing, biodiversity for	Being merged. BOB

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						biomass is missing, other comments for environment is not always clear what is ment; 4) the costs for biomass do not comply the 1- 12 with 8 - 25, seems different feedstock costs have been used?; 5) potential figures do not comply with figures mentioned in text (Monique Hoogwijk, Ecofys)	
4-81	A	3	10	3	10	delete "useful" - (1) What are useless energy services (ain't nolonger a service but disservice) and (2) conceptually this confuses the chain "primary, secondary, final, useful, services" (H-Holger Rogner, IAEA)	Accept
4-82	A	3	19	3	19	It is unclear what is meant by the strong statement that we are "on the brink"? It is unclear whether this is referring to the climate change challenge, or to some failure in supply/demand structure? Is the intent here to say that there is an increasing reliance on global energy markets? "On the brink" suggests to me some market failure? The statement should be clarified and supported by some section of the underlying text in detail. (Haroon Kheshgi, ExoonMobil Research and Engineering Company)	Being rewritten
4-83	A	3	19	3	21	Implies energy resources will soon become constrained -- this contradicts page 4 line 17-20 that abundant energy resources will be available to meet demand for centuries. (Francisco de la Chesnaye, USEPA)	Accept
4-84	A	3	20			I'm not sure that I would call the future system one of constrained supplies. We have no lack of energy (made clear in this chapter later on as well) but the system may need to see radical shifts to others supplies. So, perhaps the line should be relfect that there is shift form surplus to contstraint in certain energy carriers leading to a need to use energy more wisely or a shift to alternate, currenltly unconventional energy supply. See the previous comment about conventional supply. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Under consideration
4-85	A	3	34			"renewable" is a better word than "reliable" (or say both)	Accept

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Danny Harvey, University of Toronto)	
4-86	A	3	36		37	"annual increase in greenhouse gas concentrations of around 3ppm". This is wrong. The actual increase in carbon dioxide concentration is around 1.5ppm. The other greenhouse gases contribute very little. (Vincent Gray, Climate Consultant)	Agree
4-87	A	3	36	3	38	Suggest giving actual dates for emissions, cumulative emissions, and changes in atm composition, and giving specific recognized (eg. IPCC WG1) sources. For example current fossil fuel emissions are about 8GtC/y now not 6.8. (Haroon Kheshgi, ExoonMobil Research and Engineering Company)	Accept - updated needed
4-88	A	3	38	3	38	350 GtC - Chapter 3, p. 46, line 51 says 300 GtC -make consistent (H-Holger Rogner, IAEA)	Will check
4-89	A	3	39	3	40	"the world's rich endowment of oil…" does not fit easily with the later discussion (e.g page 25) of the constrained conventional oil resource base. As the numerous contributions to ASPO proceedings, and an increasing body of technical/scientific literature demonstrate, the likelihood is of world demand for conventional oil outstripping supplies in the 2020s and of world conventional oil production falling from some point in the 2030s. Hence the reference to hydrocarbon resources remaining abundant also sits uneasily here. (Michael Jefferson, World Renewable Energy Network/Congresses)	Rewording
4-90	A	3	40			wording 'acceptable' replace by 'sustainable' (Ad Seebregts, Energy research Centre of the Netherlands)	Accept
4-91	A	3	40	3	40	What is meant by "environmentally acceptable" is not clear: what is the line between environmentally acceptable and not environmentally acceptable? I am guessing that what is meant here is that the cumulative emissions from stabilization (at some level thought to be an appropriate limit) is less than reserves? Suggest that this be clarified. Also the use of the statement about reserves seems to contradict the statement on line 19 of this page? (Haroon Kheshgi, ExoonMobil Research and Engineering Company)	Being considered in rewrite
4-92	A	3	44	3	44	Are reductions in world GDP significant?	Accept

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Kenneth Möllersten, Swedish Energy Agency)	
4-93	A	3	44	3	44	To facilitate understanding the following wording is proposed: …have assumed drastic measures in the energy system as well as a reduced growth in world GDP. (Radunsky Klaus, Umweltbundesamt)	Accept
4-94	A	3	48	3	48	why not consequently use the same equation used earlier (the Kaya identity)? (Jan Paul van Soest, Advies voor Duurzaamheid on request of International Gas Union)	Accept
4-104	A	4	5	4	13	This paragraph hides the fact that any transition to a decarbonised world will cost money. Higher R&D expenditure is not the tool to achieve "rapid deployment and diffusion" as the text seems to suggest,. It is only the tool to reduce to the minimum (but still positive cost) the inherently higher cost of energy in a decarbonised world. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Needs adding.
4-105	A	4	5			skip 'necessary' (Ad Seebregts, Energy research Centre of the Netherlands)	Accept
4-106	A	4	5	4	11	Many of these technologies are at an early stage of development and require greater public and private investment in research, development and demonstration if rapid deployment and diffusion are to result"". My main question is how to require greater public and private investments? Elder and wise State-men with visions should take their leading role, in order to guide the world's future development in a sound economic and ecologic way! Quick development and implementation of sound technology need vision of State-men: 1) Showing the public, the way that the IPCC/UNFCCC proposed actions are needed now, in an accelerated way. Actions which should have been taken anyhow: oil and gas reserves are finite so a shift towards other reversible energy sources has to be made any how. If we do it now, then we will be less confronted with the described impacts of CC which will lead to social disruptions of the existing societies. 2) The shifts to reversible energy will be taken in the future, anyhow. The nations which are the earliest in developing and executing like France: Nuclear Energy, Spain: Solar, Denmark & Germany: Windmills will lead and can export their knowledge to other countries.3) GDP is one of the three terms (P3): the growth of the GDP of a nation is in many	Will consider. A major challenge.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						cases related to the growth of the population. The decrease in growth of world population is an important mutually agreed world issue. In this Summary more urgency in the quick, but sound implementation should be expressed. Moreover the Summary should state that the implementation has to be done anyhow and if smart applied will not cost not too much. The present estimated costs for energy transfer to reversible energy should be expressed as a percentage of the Worlds GDP per year and that percentage is not too much to avoid disaster. These costs could largely be paid by all the world nations according to the present GHG emission rates and partly by the population according to bearing capacity: the direct, progressive, international (UNFC) CC tax! Apart from the paying governments and population, investments should also be made by the industry itself. A clear division of planning and implementation tasks and responsibilities between these three groups: government (planning, and promoting , financing the demonstrative reversible techniques and later-on facilitating the real implementation), population (household level energy-use reduction) and industry (creating new technology, demonstration supported by the governments and UNFCCC-tax, and real implementation to be financed by government, and the population) should be described, otherwise no body will take first step in the process of planning, development and implementation. (Robbert Misdorp, PUM)	
4-107	A	4	5	4	8	add 'decentralised energy systems' to this list (Steve Sawyer, Greenpeace International)	Accept
4-108	A	4	7		8	There is possibility that " hydrogen and distributed energy"does not necessarily contributes to decarbonization. I propose to add a word, such as "on a certain condition" in this line. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Accept
4-109	A	4	7	4	7	This should be "carbon dioxide capture and storage" (Marco Mazzotti, Institute of Process Engineering)	Agree
4-110	A	4	7	4	8	Some of the wide range of new technologies imply increasing environmental impacts through e.g. more coal mining for CCS or increase of nuclear waste and	Noted The waste and proliferation issues are already

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						proliferation risks – we should avoid substitution of one impact by another (Gabriela Von Goerne, Greenpeace)	discussed in section 4.3.2
4-111	A	4	10	4	10	Suggest changing last half of sentence to "…demonstration to improve their prospects for rapid deployment and diffusion." Some technologies will fail; technology push can only facilitate their success, not generally guarantee it. (Haroon Kheshgi, ExoonMobil Research and Engineering Company)	Accept – being rewritten
4-112	A	4	11		12	Perhaps this finding of significantly less research investments could lead to a policy relevant conclusion (Ad Seebregts, Energy research Centre of the Netherlands)	Good point. Xiliang
4-113	A	4	16	4	24	As just remarked, "abundant sources of primary energy sources from both fossil fuels for centuries" is too sweeping [not only for conventional oil but also natural gas within 50-70 years]. Reference to "the use of cheaper fossil fuels" also offers a hostage to fortune. Page 6, lines 22/23, puts it better! Critical reference may also suitably be made to the IEA's 2005 World Energy Outlook, which is overly optimistic on conventional oil resources and the supply/demand outlook (the chapter seems only to reflect the 2004 edition). (Michael Jefferson, World Renewable Energy Network/Congresses)	Being rewritten. Accept
4-114	A	4	16	4	18	add : finite fossiles fuel, nuclear power and renewables (Antoine-Tristan Mocilnikar, Délégué Interministériel au Développement Durable)	Accepted
4-115	A	4	16	4	20	Abundant sources of primary energy sources from both finite fossil fuels and renewable energy fluxes remain available to meet global energy demand for centuries. However the rate of transition to a decarbonised world is also uncertain. So the potential emission reductions from the energy supply sector costing less than $100 /tC avoided remain at between 350-700 MtC by 2020 as identified in the TAR."" I do not understand the linkage between the second and third sentence. Moreover I object to the regularly use of the word "uncertainty" through out the WGIII FAR. Because then no government, public organizations and industry will take any real action because nobody would like to invest in uncertainties, and that is I sincerely hope not the intention of the IPCC FAR!!! If IPCC build in too many uncertainties then it will undermine its authority to state that changes are needed,	Useful comments. Will accept

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						and to state that formulation of real state-men visions, planning, development and implementation of renewable energy technology is a must, see above. In stead of the word uncertainty the wording: ""The present, best estimates indicate that ….. or "According to the adopted scenario, the best estimates indicates……..,"" should be used. (Robbert Misdorp, PUM)	
4-116	A	4	16	4	18	add "nuclear power" (H-Holger Rogner, IAEA)	Accepted
4-117	A	4	16	4	18	"Abundant sources of fossil fuels remain available for centuries" -- Strongly disagree. There are many, many studies that indicate that world oil production either has peaked or will peak within the next couple of decades. I am less familiar with natural gas and coal data, but such a blanket statement of abundance for centuries cannot be substantiated. (Stan Bull, National Renewable Energy Laboratory)	Reject. See TAR
4-118	A	4	18	4	19	add, "nuclear power provides a cheap and almost no emiting technology. According to its place, mostly determied by policital considerations and proliferation issues, the impact of energy on emissions vay largely" (Antoine-Tristan Mocilnikar, Délégué Interministériel au Développement Durable)	Noted Will be considered, but probably too strong statement.
4-119	A	4	18	4	26	Renewable energy fluxes have always been available. But their transformation into a continuous, useful form of energy is more expensive (when requested to supply ALL our energy needs) than the fossil alternative. It is an error not to mention the keyword cost in this paragraph. The sentence "the use of cheaper fossil fuels, often heavily subsidized by governments" is remarkable, very policy-relevant. Can the author provide the fraction of world coal or oil that is subsidized by governments every year? I mean, how many tons of coal and how many barrels of oil get subsidies by governments respect to the global production? (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accept
4-120	A	4	19	4	20	add, "if nuclear power is not deploied ats its economic an anti-proliferation potential" (Antoine-Tristan Mocilnikar, Délégué Interministériel au Développement Durable)	Accepted Will be accounted for in revised form.

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4-121	A	4	19			Please indicate the monetary year $ of 2005? Applies to all $ mentioned. (Ad Seebregts, Energy research Centre of the Netherlands)	Accept
4-122	A	4	22	4	28	abolishing state subsidies on fossil fuel should be a first step in any policy framework. The point should also come back in chapter 13 on instruments. (Jan Paul van Soest, Advies voor Duurzaamheid on request of International Gas Union)	Noted.
4-123	A	4	25			"unless the full benefits of environmental and health issues from their (fossil fuel) use are properly valued" -- the word "benefits" is misleading. Suggest "unless the environmntal and health issues from their use are properly valued" (Stan Bull, National Renewable Energy Laboratory)	Co-benefits preferred – will consider
4-124	A	4	26	4	27	suggest adding increased employment and the development of new industries to the list of attributes of renewable energy systems, which is well summarised in Martinot (2005) (Steve Sawyer, Greenpeace International)	Agree
4-125	A	4	29	5	5	The purpose of the paragraphs after "In summary" is unclear: the first and third bullet say pretty obvious things. The second bullet is incomprehensible, good example of wordy useless text.. The fourth bullet (with its subbullets) is again useless wordy text. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Being revised.
4-126	A	4	30			"In summary" section can contain a bullet on the importance of energy that is sustainable from the economic, social and environmental aspects This issue which has been covered comprehensively (MM 1995), (PMMM 2005) and (MMRS 2005) (Mohan Munasinghe, Munasinghe Institute for Development (MIND))	Being rewritten
4-127	A	4	35	4	41	The energy, transport and industrial sectors might be mentioned explicitly. (Kenneth Möllersten, Swedish Energy Agency)	Will consider in rewrite
4-128	A	4	35	4	41	I find this bullet point confusing. How would improving the overall delivery of energy services minimize disruptions to the climate systems (sic)? How does one integrate the provision of heating and cooling with transportation fuels? Why was industry left out of the sectors that have to participate in the improvement? What is	Willl amend

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						the environment sector? (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	
4-129	A	4	37	4	39	This can be accomplished within the primary energy, energy management, agriculture, forest, water, and waste, communication and environment sectors."" If I was I policy maker and certainly a decision maker I should certainly be satisfied by this sentence. The question here is who is doing what? So the sentence should indicate who, which country, organization/institution/institute should take initiative, policy preparation and decision making. (Robbert Misdorp, PUM)	Accept
4-130	A	4	43			Add the fuel efficiency success of hybrid vehicles with regenerative braking and their extension to other urban vehicles,who operate with stop/go operation, such as urban busses and delivery trucks. (Steven Freedman, Energy Consultant)	Chap 5
4-131	A	4	47	27		British Isles and western coast of France where the water power density of 50 to 70 kW/m exists (MICHEL PAILLARD, IFREMER)	Accept
4-132	A	5	0			Table 4.4.3 - Similar comment - Table should either include biomass cogeneration (as in pulp and paper mills) or clarify the table contents in the title. (Stan Bull, National Renewable Energy Laboratory)	Being merged and reviewed. Bob
4-133	A	5	0			Table 4.4.2 - Table should either include renewable and nuclear electricity options, or clarify in the title that the table pertains only to various fossil fuel electricity choices. (Stan Bull, National Renewable Energy Laboratory)	Noted Title will be clarified
4-134	A	5	0			Table 4.4.1 - Lower right cell (biomass - gas) should include biogas also. (Stan Bull, National Renewable Energy Laboratory)	Accept
4-135	A	6	1	6	5	Table 4.5.1 is incorrect and should be replaced with the final table in the SRCCS. The current table looks like it came from an earlier draft of this table in the SPM. (Edward Rubin, Carnegie Mellon University)	Taken into account w/expl: Sims in charge
4-136	A	6	3	18	35	Sections 4.1 and 4.2 have many policy prescriptive texts, overlaps, inconsistencies	Accepted without com. _____ in charge.

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						and haphazard treatment of historic/ current developments mixed with projections for the future. Needs major overhaul. (Bert Metz, IPCC)	
4-137	A	6	8	6	10	Check Table 4.5.2 to see if this is the final correct table in the SRCCS. It looks like it is from an earlier draft. (Edward Rubin, Carnegie Mellon University)	Accepted without com.: _____ in charge.
4-138	A	6	10	6	16	Updated figures of "World Energy Outlook 2005 - Middle East and North Africa Insights" (IEA 2005) could be added. (Joachim Schleich, Fraunhofer Institute Systems and Innovation Research)	Accepted without com.: Sims in charge.
4-139	A	6	10	6	16	This demand will continue to drive the global energy technology industry to provide new and improved infrastructure as well as energy carrier and conversion systems which will require a total investment of $US17.5 trillion (or around 1% of global GDP) by 2030 (IEA, 2004). Total annual capital investment by the global energy industry is around US$280 with energy R&D investment of around $US8.1 billion by governments (IEA Statistics, 2005) and perhaps half to a third of this again by industry"". Are these US$ 17.5 trillion for new and improved infrastructure in order to reduce the GHG emissions? With other words are the 17.5 trillion, the extra costs in order to reduce the GHG emissions by how much? That percentage of reduction of GHG emissions should then also be mentioned. What is meant by: …. total investment of US$ 17.5 trillion is total over which period: one year, 10 years, 50 years? Expressed as 1% of the global GDP, then it looks like that 17.5 trillion is meant per year, because GDP is expressed as per year! What means: Total annual capital investment by the global energy industry is around US$280 ……US $280 ? ……. Are that millions, billions US$? And what kind of investment is this? This entire important paragraph needs rephrasing! In conclusion: the Summary is certainly contributive in providing all kinds of different types of overviews, however its contents should be better accommodated in the Introduction of Chapter 1. Positive simple examples, demonstration/pilots should be mentioned in the Summary of Chapter 4 , from the many examples mentioned in the text of Chapter 4.7: several real pilots are mentioned and some of these outspoken positive	Accepted /com.: Ralph in charge.

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						examples should also come back in the Chapter 1: Introductions and in the not yet existing Summary of the total WG III Report. The mentioning of some mitigating successful pilots, such as some relatively simple projects like Toyota Prius, up-front in the IPCC FAR, should have an enthusing effect on the readers, decision makers to promote the start the necessary planning, development and implementation of GHG reducing measures. The present text of the Summary of Chapter 4 and the Introduction Chapter 1 is written in a too high level abstraction for policy and decision makers. The future policymaker summary should take this observation on board.Furthermore, the tone is too hesitant, too much so-called ""uncertainties"", and that needs to be rephrased, see above. (Robbert Misdorp, PUM)	
4-140	A	6	13			insert "cumulative" after total, if that is what you mean (Danny Harvey, University of Toronto)	Accepted without com
4-141	A	6	13	6	14	You can refer to our most recent work, World Energy Outlook 2005, where total investment required in 2004-2030 is estimated as $17 trillion. (Fatih Birol, International Energy Agency)	Accepted w/com.: Ralph in charge.
4-142	A	6	14			(IEA, 2004) reference: which one in 2004? Applies to whole chapter (IEA. 2004) references! Not mentioned repeatedly. (Ad Seebregts, Energy research Centre of the Netherlands)	Rejected w/com.: It was 2004c, but it is now 2005 WIO.
4-143	A	6	14			check figure: Ch 11, p17 line 13 quotes 16 trillion (Peter Bosch, IPCC TSU WGIII)	Taken into account. New 2005 number.
4-144	A	6	15			I think you mean US$280 billion (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Accepted without com.
4-145	A	6	15			there is a factor missing from the $280 (Roger Gifford, CSIRO)	Accepted without com.
4-146	A	6	15	6	15	I assume that this should be US$280 billion. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	“”
4-147	A	6	15	6	15	US$280? US$28 billion?	“”

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						(Ryota OMORI, Japan Science and Technology Agency)	
4-148	A	6	15			I think that you mean "US$280 million, with cumulative energy …" (Danny Harvey, University of Toronto)	“”
4-149	A	6	15	6	15	Cheap US$280. Add billion (H-Holger Rogner, IAEA)	“”
4-150	A	6	15	6	15	US$280 what? billion? (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	“”
4-151	A	6	15	6	15	It is proposed to insert "billion" after "US$280". (Radunsky Klaus, Umweltbundesamt)	“”
4-152	A	6	15	6	15	US$280 (should be US$280 billion) (Muhammad Latif, Pakistan Atomic Energy Commission)	“”
4-153	A	6	16	6	16	Suggest references and quantitative information be given on investment in energy infrastructure and private sector R&D. (Haroon Kheshgi, ExoonMobil Research and Engineering Company)	Accepted w/com.: it will be extrapolated from USA data.
4-154	A	6	16			Somewhere in the arena of the Introduction or section 2, the chapter misses an important opportunity to bring structural clarity. Energy-related emissions are essentially a function of six economic system: 3 driving sectors (buildings, industry and transport) and 3 conversion-delivery sectors (electricity, refining, and direct fuel transport of pipelines, coal shipping etc). This would help to explain the secftoral structure of the WGIII and also define sharply the coverage of this chapter. Somewhere between the complexity of Figs 4.1.2 and Fig 4.2.1 might it be useful to include a simple flow chart to illustrate this (one is in Grubb, M. J. (2004). "Technology Innovation and Climate Change Policy: An Overview of Issue and Options." Keio Economic Studies 41(2): 103-132, though I believe Socolow has now considerably improved on this)? (Michael Grubb, Cambridge University)	Taken into account: we’ll consider combining elements from our three Figs. (4.1.2, 4.2.1 and 4. 4.1 into one figure). Ralph in charge.
4-155	A	6	19			Consider adding computerized dispatch of airplanes from airport gates rather than have them queue up on the tarmac cosuming fuel (and emitting pollutants) without	Rejected because it is too much detailed.

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						delivering any energy service to the vehicle or society. (Steven Freedman, Energy Consultant)	
4-156	A	6	23			policy prescriptive (Bert Metz, IPCC)	Accepted without com.
4-157	A	6	39			policy prescriptive (Bert Metz, IPCC)	Rejected: not policy prescriptive.
4-158	A	6	42	6	43	It is proposed to substitute the term "sustainable energy developers" by a wording as follows: .. and which countries will develop and deploy sustainable energy". (Radunsky Klaus, Umweltbundesamt)	Accepted withuot com.
4-159	A	6	47			proposition value, what is that? (on page 7, line 6 it says value proposition!) (Bert Metz, IPCC)	Accepted w/com.: we'll define here what bis "value proposition".
4-178	A	7	0			Table 4.5.3 comment: We have concerns in the column Technical Potential up to 2050 (EJ) - please see attached email from Elizabeth Brown. (Stan Bull, National Renewable Energy Laboratory)	Accepted: the e-mail will be reviewed.
4-179	A	7	0			Table 4.5.3 - Column heading of "Consumer costs" should be "Consumer prices", as most analysts and economists use the terms. More importantly, having similar but not identical information quoted in tables 4.3.1 and 4.5.3 is confusing. The data referenced in table 4.5.3 is from 2001, suggesting the 2004 reference from table 4.5.1 may be better (unless that is simply quoting the old 2001 reference!) I believe there are more current sources for renewable price info; please contact me if you need help. Lastly, see above for one recent PV reference I had at my finger tips. (Stan Bull, National Renewable Energy Laboratory)	Accepted w/com.: Tables will be combined and updated.
4-180	A	7	0			Values for current approximate use (EJ/yr) are inconsistent with those shown in Figure 4.3.1 of this Chapter (4). (Muhammad Latif, Pakistan Atomic Energy Commission)	""
4-181	A	7	0	7		Table 4.5.3. This table is redundant with Table 4.3.1 and has some inconsistencies. I would suggest combining the information from these 2 tables into one table and eliminate the inconsistencies. The low end of the range for projected investment costs for gas, coal, solar PV and wind appears unrealistically low. (For solar and	""

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						wind see 2050 projections from DOE, Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs (FY2006- FY2050), Long-term Benefits Analysis of EERE's Programs (Chapter 5), p. 5-21 to 5-29. (Steve Clemmer, Union of Concerned Scientists)	
4-160	A	7	1			It should be noted that useful lifetimes can vary among plants and infrastructural components (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted, but it is too much detailed to be incorporated.
4-161	A	7	1	7	3	TABLE 4.5.3; The technical potential figures are NOT correct, or are NOT expressed in EJ; What is the relation with Table 4.3.1?; For biomass, what is the relation between the two mentioned costs; Why using WEC/IIASA, whereas in table 4.3.1. other references where mentioned and in text even other references.... (Monique Hoogwijk, Ecofys)	Accepted w/com.: the two tables need to be combined and consistent, including references. Ralph is in charge.
4-162	A	7	3			Refer to the notion of 'lock-in' and inertia in relation to useful lifetimes of technology (Ad Seebregts, Energy research Centre of the Netherlands)	Taken into accoun if relevant.
4-163	A	7	5			You do not, in this statement, allow for diffusion of new types of techologies (often focussed on what one might call the "convenience" market). It presumes that only alternatives to current technologies penetrate. There are whole sets of technologies breaking into the market that are energy using and counter the efficiency gains of economic, efficient "alternative" technologies. Perhaps, in response them recently istalling efficienct CF lights, people expend the energy saved by investing in patio heaters and desktop coffee warmers, for example. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Accepted w/com.: but not on point.
4-164	A	7	15	7	28	Updated figures of "World Energy Outlook 2005 - Middle East and North Africa Insights" (IEA 2005) could be added. (Joachim Schleich, Fraunhofer Institute Systems and Innovation Research)	Accepted without com.
4-165	A	7	15		16	Accoding to "World Energy Outlook 2005" published by IEA, global primary energy demand is projected to increase by 52% from 2003 to 2030. It would be	Accepted w/com.: the figures'll be updated.

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						necessary to revise up if possible. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	
4-166	A	7	15	7	16	A 52% global increase in primary energy demand is anticipated by 2030 in WEO2005. (Fatih Birol, International Energy Agency)	Accepted w/com.: the figures'll be updated.
4-167	A	7	15			60% global increase compared to what baseline? (Stan Bull, National Renewable Energy Laboratory)	Accepted without com.: will add "above today".
4-168	A	7	21	7	22	Change the end of this sentence to "… 2.1 GtC being accumulated in the atmosphere." The current text implies that atmospheric CO2 would be increasing at about 4 ppm/yr. Actually it is increasing at about 2 ppm/yr because typically only half of the carbon emitted accumulates in the atmosphere, though the fraction varies from year to year. (TAR, WG I, Pg. 185). (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Taken into account: will add "into the atmosphere".
4-169	A	7	22			This factor of 2.1 Gt C emitted causing a 1ppm CO2 concentration increase is wrong. That is the mass increase in the atmospheric content equal to a volumetric fraction increase of 1ppm. CO2 re;eased from fosisl fuel burning is partitioned between terrestrial, marine and atmopsheric pools. Since the airborne fraction of fossil CO2 released averages about 55% (the other 45% goes into the oceans and the terrestrial biopshere) the amount released from fossil fuel burning to give 1ppmv increase in atmospheric CO2 is 2.1/0.55=3.8Gt C (Roger Gifford, CSIRO)	""
4-170	A	7	22	7	24	that is not the perspective of the assessment; see ch 3 for the long term stabilisation context (Bert Metz, IPCC)	Accepted w/com.: the paragraph'll be dropped.
4-171	A	7	26	7	27	It is proposed to be more explicit and specific about the emission reduction compared to business as usual linked to the mitigation options indicated. It would be relevant to learn the percentage of emission reduction compared to business as usual as well as compared to levels in the year 1990. Furthermore it would be relevant what stabilization level could be within reach following such emission	Accepted w/com.: it'll be included in the new section 4.4.

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						pathway. (Radunsky Klaus, Umweltbundesamt)	
4-172	A	7	27			the analysis is not about "avoiding all together" but about substantial reductions in the light of stabilisation (Bert Metz, IPCC)	Accepted w/com.: “”
4-173	A	7	29			"Figure 4.1.1": It would be adequate to adopt IEA statistics which is compiled through energy-balance format and has higher reliability as a result. Please find attached file "Fig4.1.1.xls", using IEA Energy Balances. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Accepted w/com.:
4-174	A	7	29	7	30	You can use IEA's numbers in WEO2005. (Fatih Birol, International Energy Agency)	Accepted without com.
4-175	A	7	29			Figure 4.1.1: I do not like this figure; it should have all curves along the same axis, to make comparison easier. (Marco Mazzotti, Institute of Process Engineering)	Rejected because it is a personal preference.
4-176	A	7	32			"Since reduced economic growth is generally unacceptable," -- This is a blatant philosophical assumption that seems inappropriate in this document. I think the intent of the author is preserved if the phrase is simply dropped. (Stan Bull, National Renewable Energy Laboratory)	Accepted without com.
4-177	A	7	34	7	35	This decoupling is now apparent in China (as referenced later in the chapter, p.15, lines 39-42) although not sure if you include that in S.E. Asia; nor am I clear why S.E. Asia is the relevant example here. (Steve Sawyer, Greenpeace International)	“”
4-182	A	8	1	8	1	demand for energy services will increase. Whether or not and how much increase in primary energy demand follows from that remains to be seen (Steve Sawyer, Greenpeace International)	Accepted without com.
4-183	A	8	1	8	11	Does this paragraph really belong in Chapter 3 on scenarios? (Casey Delhotal, USEPA)	Accepted without com.
4-184	A	8	2	8	2	Figure 4.1.3 should be updated to use the latest population projections. These are discussed in Section 3.2.1.1.	Accepted without com.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	
4-185	A	8	8	8	11	Delete this sentence. While 80% of the world's population will be living in the developing world, the situation of these people varies greatly. As detailed on Pg. 15 of this draft, most are served by grid-based electricity. Lumping all of these people into a single category is both unfair and misleading. The commonly quoted number is that 1.6 billion people do not have access to reliable electricity. Use this value or some equivalent measure of lack of access to energy services. Also, while it has become fashionable to cite lack of access to basic economic needs as a reason for international terrorism and other security issues, the evidence indicates a far more complex situation. The suicide bombers of Sept. 11, this past summer's London transport bombers, and the rioters in France all had full access to modern energy services. Their grievances stemmed from other issues. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	“”
4-186	A	8	9			change "an unchanged situation" to "an unchanged energy situation", and drop the parentheses - -the points made about issues are very important, not parenthetical. (Stan Bull, National Renewable Energy Laboratory)	Accepted without com.
4-187	A	8	12			Fig 4.1.3: the main message of this graph (bulk of population in developing countries) can easily been given in two sentences. This graph is not needed for that. Note also that it might not align with UN2005 as used in Ch3. (Peter Bosch, IPCC TSU WGIII)	“”
4-188	A	8	13			no need to show population projections here. Refer to ch 3. (Bert Metz, IPCC)	“”
4-189	A	8	17			I suggest adding after "clear)" "combined with progressively improving energy use efficiencies" (Roger Gifford, CSIRO)	“”
4-190	A	8	19	8	30	The text implies that these three WEC scenarios cover the range of options. I doubt this is the case, given the 600 base case scenarios that Chapter 3 refers to. Change "three possible scenarios" to "three sample scenarios." Also, why have these scenarios been chosen over the SRES scenarios?	Accepted w/com.: the phrase will be “three example scenarios covering a wide range”.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	
4-191	A	8	20			Can the author add a few words as to why these three scenarios were chosen for mention, among the thousands available? (Stan Bull, National Renewable Energy Laboratory)	“”
4-192	A	8	22	8	30	Suggest using a wider range of published scenarios, including but not limited to: World in Transition: Towards Sustainable Energy Systems (WGBU, 2005) http://www.wbgu.de/wbgu_jg2003_engl.html; Energy Revolution: a sustainable pathway to a clean energy future for Europe (Greenpeace, DLR, 2005); http://www.greenpeace.org/international/press/reports/energy-revolution-a-sustainab (Steve Sawyer, Greenpeace International)	“”
4-193	A	8	32	8	39	This paragraph is couched in very certain terms about what will happen by 2100. I suggest that it be worded more tentaitively given the the cause of the future is always highly uncertain. (Roger Gifford, CSIRO)	Accepted without com.
4-194	A	8	36	8	39	It is necessary to specify what types of “adverse environmental and health impacts” are reduced. (Kenichi Oshima, Ritsumeikan University)	Rejected because it is too detailed for this chapter.
4-195	A	8	36	8	39	It is necessary to specify what type of adverse environmental and health impacts are reduced by switching solid fuels to electricity and gas. (Masatake Uezono, Citizens' Alliance for saving the Atmosphere and the Earth)	“”
4-196	A	8	38			Conversion to liquids, whether biofuels or coal liquefaction, may not occur as readily as implied here. (Michael Jefferson, World Renewable Energy Network/Congresses)	Accepted w/com.: we’ll use the word “may” instead of will.
4-197	A	8	42			"hydrogen will only become more prevalent towards the end of the century" -- Suggest a bit more optimistic wording is warranted, such as: "in developing countries, hydrogen is likely to begin making an impact on energy systems by mid-century" (Stan Bull, National Renewable Energy Laboratory)	Accepted w/com.: Instead of “the end of the century” we’ll put “after mid (century)”.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-198	A	8	50			It is proposed to highlight in the introduction also the expected reduction in costs for renewables as well as the range of their contribution in the energy system by 2050 and 2100 according to the majority of emission scenarios. (Radunsky Klaus, Umweltbundesamt)	Noted without com.
4-199	A	9	0			what is this material doing here? (this is an introduction to the mitigation options in the energy sector) (Bert Metz, IPCC)	Accepted without com.
4-243	A	9	0			These options from (IPCC, 2001) are not the same or in same order as in Section 4.5. Provide linkage to section 4.5 or to 'demand' chapters (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted without com.
4-200	A	9	1			Skip 4 (Ad Seebregts, Energy research Centre of the Netherlands)	Noted without com.
4-201	A	9	2	4	2	Erratum: 4.1.1 Mitigation options (FÉLIX HERNÁNDEZ, IEG-CSIC)	Noted without com.
4-202	A	9	4	9	4	Change to "Several options to reduce net energy-related GHG emissions …" CO2 is also emitted by the smelting of metals, some chemical processes, and cement and lime manufacture, all of which are discussed in Chapter 7. Changing from CO2 to GHG emissions allows inclusion of the last item on your list, reducing methane leaks. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted without com.
4-203	A	9	5	9	5	Add reference to IPCC 2000b (land use) and IPCC SRCCS 2005 (IPPC Special Report on CO2 Capture and Storage, 2005). Delete reference to IPCC 2000a (emissions scenarios)? (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted without com.
4-204	A	9	7	9	14	Subsection 4.1.1: In addition to improving energy conversion and/or utilisation efficiency, reducing the loss of energy transmission and/or storage will play a role to reduce carbon dioxide emissions. (Takanobu Kosugi, Ritsumeikan University)	Noted without com.
4-205	A	9	10	9	11	I would prefere to say: ... **can** also reduce emissions substantially .... In	Accepted without com.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						practice, the emission reduction of a cogeneration-project is complex and depends on many variables (old fuel vs. new fuel, old technologie vs. new technology and more). E.g. replacing a good, but separate gas generation of heat and electricity by a coal cogeneration plant is not a good mitigation option. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	
4-206	A	9	11	9	13	Is this true in the case of vehicles? Efficiency improved strong, but at least in many developed countries this improvement was eaten up partly by increasing power, weight and additional comfort units. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Noted without com.
4-207	A	9	14	9	15	Explain in a couple of more lines what is it meant by "Dematerialisaiton of processs..." (as in page 72). (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Noted without com.
4-208	A	9	16	9	24	Is it necessary to include biomass as both a 'less carbon-intensive fuel' and as a 'renewable'? It is important to point out that it must be sustainably grown/harvested biomass. (Kenneth Möllersten, Swedish Energy Agency)	Accepted without com.
4-209	A	9	16		30	It's better and more clear to put together paragraph "Increase the use of renewable energy sources..." and "Provide more nuclear power ..." to "Switch to less carbon intensive fuels ..." as fuel swithing to less caobon intensive energy. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Noted. Accepted without com.
4-210	A	9	16	9	19	It should be mentioned that this is not possible in the long run, since there is much more coal than natural gas. (Marco Mazzotti, Institute of Process Engineering)	Noted without com.
4-211	A	9	18			indicate what the emission reductions are in relative or percentage terms (Danny Harvey, University of Toronto)	Accepted without com.
4-212	A	9	18	9	19	given that this number can vary significantly, depending on the type of plant used, as well as the variations in coal quality, I think that it would be useful to point out	“”

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						here that this is nearly (and can be more than) double the efficiency, i.e., electrical output per unit of CO2. (Steve Sawyer, Greenpeace International)	
4-213	A	9	21			List should include geothermal (Stan Bull, National Renewable Energy Laboratory)	Accepted without com.
4-214	A	9	25			One issue not dealt with in many current energy transformation devices is thermal pollution. I note it here because nuclear plants generate a significant amount of waste heat that must be disposed of into the environment. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Noted This aspect applies to all condensing power thermal plants. The most advanced NPPs in the market have improved generation efficiency; exceeding 35%
4-215	A	9	25			Yucca will be filled immediately if waste is not processed Additional long-term sites must be identified TRU burners must be built Those who support nuclear power don't generally talk about the insurance issues, but the Price-Anderson law extension is required in US to limit utilities' liability. This law can be perceived as unfair to other technologies, such as renewables, which are fully insured. However without the law, I believe, the nuclear industry in the US would be dead. Even given favorable political landscape, it will take decades to build these plants. (Michael Bowman, GE Global Research)	Noted Possibility of waste processing is discussed in section 4.3.2. In USA the utilities have formed an insurance pool; their joint total liability covers of off-site economic damage except those of very low probability events. The liability arrangement could be mentioned in section 4.3.2
4-216	A	9	25	9	25	The text should read "provide more nuclear power, fission and/or fusion, with zero stack emissions from power plants and low emissions from the front-end cycle. The rate at which the use of fission can be increased will be determined by resolution of technical issues of safety, waste management and nuclear profileration to the satisfaction of the public and governing authorities. The time when fusion can be deployed will depend on the level at which the R&D is supported and the success of international (e.g., ITER) and national R&D programs." It is problematic to suggest, as in the existing text, that the problems for fission are political rather than technical. The political and technical aspects are intertwined as described in the proposed text. It is also incorrect to leave fusion out of this paragraph. (Robert Goldston, Princeton Plasma Physics Laboratory)	The text suggestion will be shortened. BUT fusion will almost certainly not have a major impact before 2030 or even 2050.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-217	A	9	25	9	29	To suggest that nuclear power is a mitigation option and not include its significant environmental impacts - is to ignore the fact you cannot solve one environmental problem with a0nother environmental disaster. The nuclear process emits other greenhouse gases besides carbon dioxide with far stronger global-warming potential such as chloro- and fluorohydrocarbons and takes a significant amount of energy in every step of the cycle from mining to burning to dealing with the radioactive waste. Nuclear power is a major environmental threat: radiation released into the environment has led to the contamination of soil, air, rivers and oceans; causing cancer and other diseases in people and nuclear weapons proliferation is a major concern. (Kirsten Macey, Climate Action Network Europe)	Rejected The limiting factors of nuclear power are discussed in section 4.3.2. The discussion of safety and environmental aspects will be somewhat expanded there.
4-218	A	9	28		29	As characteristics of nuclear power plant, adding "(enhancing) self-sufficiency" would be better. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Noted Enhanced self-sufficiency is not evident
4-219	A	9	29	9	30	hi (Arthur Lee, Chevron Corporation)	Noted
4-220	A	9	30	9	30	• P.9. L. 30. Among the elements likely to determine the future of nuclear power, I feel that a reference to the increasing market liberalization in some countries should be added in this sentence. Economic competitiveness is mentionned in the same paragraph. However, market liberalization has a specific impact on the potential growth of the nuclear power industry. The cost per kWh of nuclear power production is low which makes it a very competitive option. However, in some liberalized markets, private entities are not keen on investing in nuclear plants because the scale required for the investments and liability issues over long periods make the nuclear option less attractive than other options such as gas for instance in spite of higher production cost for gas-based power. The assessment differs very much from country to country in relation with the level of market competition. Hovever, the impact of market competition should not be neglected in assessing future possible trends. A reference to market liberalization is given in section 4.5.5 p. 58 L. 34. It should be stressed also in other sections.	Accepted The effect of market liberalisation is a key factor worth of mentioning together with effects of some other aspects, such as emission trading. In some countries (e.g. in Finland) the nuclear utility is owned by energy intensive industry, which reduces the effect of market liberalisation to the electricity price.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Philippe Tulkens, TERI School of Advanced Studies)	
4-221	A	9	31	9	32	Is the SRCCS the most suitable reference for biological sinks. Would not 200b (SR LULUCF) be more appropriate? (Kenneth Möllersten, Swedish Energy Agency)	Accepted without com.
4-222	A	9	31	9	37	In addition to enhancement of biological sinks reduced degradation of biological sinks is a vital measure. Deforestation is responsible of a significant share of present net CO2 emissions to the atmosphere. (Kenneth Möllersten, Swedish Energy Agency)	Noted without com.
4-223	A	9	31	9	32	The IPCC SRCCS 2005 does not talk about this (Marco Mazzotti, Institute of Process Engineering)	Accepted without com.
4-224	A	9	32	9	32	Correct reference should be IPCC 2000b (land use) (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted without com.
4-225	A	9	34	10	34	Modify the wording by: "Carbon sequestered biologically…" (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted without com.
4-226	A	9	34	9	34	Modify the wording by: "…enhance their carbon sequestration capacity…" (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Noted without com.
4-227	A	9	35	9	36	The parenthetical "(as in plantation forests)" should be removed because it is unnecessary and creates the impression that platnation forests are particularly susceptible to fires when in some cases they may be less susceptible than natural forests. (Reid Miner, NCASI)	“”
4-228	A	9	38	9	46	This para may give the misleading impression that the emissions from the transportation sector cannot be addressed with CCS technology. (Kenneth Möllersten, Swedish Energy Agency)	Notes without com.
4-229	A	9	38	9	38	Capture and "store" CO2 (not sequester), in line with IPCC SRCCS (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted without com.
4-230	A	9	38	9	39	Instead of merely capturing and sequestering CO2, perhaps capturing, transporting and sequestering CO2. The phrase "physical or chemical storage in geological sites or in the ocean" is misleading. From a geologic perspective, CO2 can be essentially	Noted without com.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						stored in subsurface geologic formations under the terrestrial continent, under the ocean bottom, or in the ocean. (Veronica Brieno Rankin, Michigan Technological University)	
4-231	A	9	38	9	39	Modify the sentence by: "Capture and store CO2 from fossil and biomass fuel combustion…using physical or chemical storage in geologic sites, in the ocean or by industrial transformation into carbonate minerals (IPPC SRCCS, 2005)". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Notes without com.
4-232	A	9	38	9	38	This should be "capture and storage of CO2..." (Marco Mazzotti, Institute of Process Engineering)	Accepted without com.
4-233	A	9	39	9	39	It is proposed to delete "or in the ocean" because according to the IPCC Special Report on Carbon Capture and Storage this option is still in the research phase and the IPCC was not in a position to assign a quantitative figure to a hypothetical mitigation potential of ocean storage and thus ocean storage seems to be of a different quality and does not qualify to be mentioned. (Radunsky Klaus, Umweltbundesamt)	Accepted w/com.: possibly
4-234	A	9	41	9	42	Modify the sentence by: "…and other major centralized sources. It should also be able in the longer term to reduce part of the dispersed CO2 emissions from transport and distributed energy supply systems, when combined to fossil fuel-based production of hydrogen and electricity. The issues of concern...". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted without com.
4-235	A	9	42			DJ Delete the words " of concern". The IPCC report on CCS is dealing with the issues as motioned (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted without com.
4-236	A	9	42			Delete the words " of concern". The IPCC report on CCS is dealing with the issues as motioned (Daniel Jansen, Energy research Institute of the Netherlands)	“”
4-237	A	9	43	9	44	The use of 'carbon dioxide' is inconsistent with previous writings where 'CO2' is used (e.g., line 38 in this chapter). I think that 'carbon dioxide (CO2)' should be used once per chapter (in the beginning) and the rest should be written merely as	“”

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						'CO2' unless the context is from a molecular standpoint. (Veronica Brieno Rankin, Michigan Technological University)	
4-238	A	9	45			Replace disposal with storage (Daniel Jansen, Energy research Institute of the Netherlands)	“”
4-239	A	9	45			DJ Replace disposal with storage (Ad Seebregts, Energy research Centre of the Netherlands)	“”
4-240	A	9	46	9	46	Check this reference in the final list. isnt' it IPCC SRCCS 2005? (Marco Mazzotti, Institute of Process Engineering)	“”
4-241	A	9	47	9	48	This para concerns reduction of methane emissions while the introducing sentence to the list on line 4-5 (same page) refers to reduced carbon dioxide emissions. (Kenneth Möllersten, Swedish Energy Agency)	Accepted w/com.: it is necessary to redraft line 4-5 and check the references in order to assure they refer to GHG in general.
4-242	A	9	47	9	48	This is an option for greenhouse gas emission reduction, not for carbon dioxid emission reduction. The titel of the list (line 4) should be corrected therefore. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	“”
4-253	A	10	0			Figure 4.1.1.This figure is not clear at all and must be revised. Make a clearer inset, clarify what the white area in the uranium column is. What are the numbers below the columns? (Marco Mazzotti, Institute of Process Engineering)	Rejected because it is a personal preference.
4-244	A	10	1	10	19	this material belongs in 4.9 (Bert Metz, IPCC)	Accepted without com.
4-245	A	10	2			The wedge concept is a construct not supported by some action-inducing mechanism, much like the outdated stepwise cost curve for GHG reduction potentials used in older documents by, among others, Lovins and EPRI. I'm not aware of any supporting work indicating how these wedges might actually be obtained - i.e., the policy side to their definition is lacking. I recognize its discriptive advantages in pointing out where GHG reduction might come from but it shortcomings (how do they know that we will get xx from any particular activity) should be mentioned.	Accepted without com.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	
4-246	A	10	4		11	Figure and text on wedges is not clear to me: what is the message? Moreover. Fig displays seven wedges. Text provide more than 7 (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted without com.
4-247	A	10	10	10	11	The overall term used in the original paper is Forest management, which includes reduced deforestation and reforestation. (Kenneth Möllersten, Swedish Energy Agency)	""
4-248	A	10	19			Add 'policies' as factor (Ad Seebregts, Energy research Centre of the Netherlands)	""
4-249	A	10	22	11	35	It is prety useless to summarise the whole energy section of TAR in this (not very accurate) way. The reader will not remeber the specific numbers/ conclusions (even if they were formulated correctly) by the time the respective issue is discussed. So only useful way is to make TAR reference in appropriate places to put new findings in perspective or to say there is no difference. The section has a lot on technology transfer and barriers to impelenting mitigation options and not in conformity with TAR. (Bert Metz, IPCC)	""
4-250	A	10	38	10	45	The TAR examined estimates of fossil fuel consumption relative to resources and known reserves of fossil fuels. It estimated that 296 GtC were released from fossil fuel combustion between 1860 and 1998, and annual releases were approximately 6.5 GtC/yr. Known reserves were equivalent to 1549 GtC, with a conventional resource base estimated at 4,959 GtC. Methane clathrates contain an estimated additional 12,000 GtC. Hence there is at least 5 times as much carbon in proven conventional reserves of oil, gas and coal as has been burned during the entire industrial revolution. Fossil-fuel scarcity, at least at the global level, is therefore not a significant factor in considering climate change mitigation"". The underlined sentence, although possibly right in itself, could invite future uncontrolled burning of non-renewable energy sources. And that will not be the message of IPCC I hope. If these types of statements will be taken on board then they should be followed by	Noted without com.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						statements such as: The consequences burning non-renewable energy sources in an accelerated way will be an acceleration in GHG atmospheric concentrations. The present strongly human induced increase to a level 350 ppm CO2, has never been observed during the last several hundreds of thousand of years (natural variation width 180 - 280 ppm CO2) and that extrapolation to undesired 600 ppm levels could imply dangerously developing impacts of Climate Change. (Robbert Misdorp, PUM)	
4-251	A	10	40	10	40	Change "…and annual releases were approximately 6.5 GtC/yr." to "...and releases were approximately 6.5 GtC in 1998." Annual releases have been growing steadily so any value is valid only for a short period of time. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted without com.
4-252	A	10	46	10	46	Modify the wording by: "…if burned without CO2 capture and storage,…". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted without com.
4-254	A	11	1	11	1	FIGURE 4.1.3. this figure should NOT be included in Chapter 4, please refer to Chapter 3 there is one section that deals with population scenarios (Monique Hoogwijk, Ecofys)	Accepted without com.
4-255	A	11	2	11	2	FIGURE 4.1.4. Same, this figure does not belong in Chapter 4, Chapter 4 should be on 2025 - 2050. In addition it was agreed to use SRES scenarios, or am I wrong, IEA/ WEC may be good reference (Monique Hoogwijk, Ecofys)	Rejected because it is IIASA/WEC.
4-256	A	11	15	11	15	"the physical capture and storage of CO2" doesn't sit well with me. It alludes that the CO2 will be injected on-site. Collectively, much of the global CO2 that will be captured and injected to reduce atmospheric anthropogenic emissions will probably need to be captured and transported off-site to a suitable geologic formation and then injected for permanent disposal. Moreover, the term 'storage' alludes that the injector will come back and claim the CO2 at some point in time, which exposed the injector to legal liability. Injected CO2 as we know it to be will be disposed into a geologic formation where it will remain until it disapates so that it can be reintegrated with the natural carbon cycle and will not be retrived from the subsurface by the injector.	Accepted w/com.: "the physical capture, possible transport and storage of CO2"

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Veronica Brieno Rankin, Michigan Technological University)	
4-257	A	11	38			Section 4.2: 1) Change 4.2.3 title to " global devement trends" , and change 4.2.5 to 4.2.4 "Regional development trends"; 2) Change 4.2.4 to 4.2.5, and revise the titel to "Emission trends" (delete all gases because this section only discusss CO2, CH4 and N2O). (Wenying Chen, Energy, Environment, and Economics Research Institue, Tsinghua Univerisity)	Noted without com.
4-258	A	11	38			treat energy demand trends separate from energy supply trends. Use material form later section on this and concentrate all in 4.2 (Bert Metz, IPCC)	""
4-259	A	11	41	11	43	What is the basis for this very dramatic statement? As I read through chapter 4, the tone is not necessarily that dire. However, the tone is very dire, stating: "The existing global energy system is no longer capable of supporting economic activity, pr (Arthur Lee, Chevron Corporation)	Noted without com.
4-260	A	11	41		43	Provide reference(s) supporting this statement (Ad Seebregts, Energy research Centre of the Netherlands)	""
4-261	A	11	41	11	44	The statement "Recent liberalisation of energy markets in many countries has led to energy supply security and affordability of energy services taking priority over resulting environmental impacts" is not clearly supported in the literature and could be seen as policy prescriptive. (Spencer Edwards, Australian Greenhouse Office)	Accepted without com.
4-262	A	11	41	11	42	while functioning competitive markets may indeed increase supply securityin the short run, this is not necessarily the case in the longer run because investments with longer amortization periods and often lower returns are not made due to short-term shareholder value maximization (drawing on cheap oil does not prepare you for an area of high prices or disruptions) (H-Holger Rogner, IAEA)	""
4-263	A	11	41	11	43	This statement seems to be too optimistic. Liberalisation can lead also to the	""

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						contrary effect (i.e. reduce supply security) and apparently has done this in several countries. Increasing competition leads to sinking investments in grid and plants. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	
4-264	A	11	41	11	43	It is strongly recommended to include a reference to literature to the statement that recent liberalisation of energy markets in many countries has led to energy supply security. It is also noted that energy supply security is poor in many countries with liberalised energy markets and that investments into the energy system have been deferred due to uncertainties and that this lack of investment reduces security of supply and results in an increase of price. (Radunsky Klaus, Umweltbundesamt)	""
4-265	A	11	46	11	46	Line 46 should read "fossil fuel, geothermal heat, and minerals capable of fission or fusion, produced during…", since the fuel for fusion is not radioactive. (Robert Goldston, Princeton Plasma Physics Laboratory)	Rejected: See 4-216
4-266	A	12	1	12	2	TECHNOLOGY is missing here (H-Holger Rogner, IAEA)	Accepted without com.
4-267	A	12	4			General comment about some of the graphs and figures. Some, like this one, are far to small to read (I know that will be corrected for the final edition but it prevents me from providing critique) and far too complex. One needs to spend considerable time studing this sort of graphic to gain from it - and there are a nubmer of others like it later on. I recommend simplification and, if needed, disaggregation. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Noted without com.
4-268	A	12	4			Fig 4.2.1 which year? Figures uranium reserves not consistent with Table 4.3.1. See also comments there (ch4, p 19) (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Noted without com.
4-269	A	12	20	12	20	delete "useful" - (1) What are useless energy services (ain't nolonger a service but disservice) and (2) conceptually this confuses the chain "primary, secondary, final,	Accepted without com.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						useful, services" (H-Holger Rogner, IAEA)	
4-270	A	12	23			Light is not an energy unit, so you can't say that 320 units of primary energy produce 1 unit of "useful" light energy. Light flux is measured in units of lumens; lumens is the electromagnetic flux (which does have energy units) from a lamp weighted by the sensitivity of the human eye to radiation. Shifting the spectral distribution of radiation without changing the total energy flux will change the light output, but also the percevied colour. The discussion seems to imply that the "efficiency" in producing light is only 1/320. I don't think this number is meaningful. What is meaningly is the relative improvement that can be achieved compared to present powerplants and standard light bulbs. (Danny Harvey, University of Toronto)	Noted without com.
4-271	A	12	23			Fig. 4.2.2: I suggest the use of EJ instead of TWh (Stefano Caserini, Politecnico di Milano)	“”
4-272	A	12	25			DJ Please indicate whether efficiencies are based on HHV or LHV. This must be clear in the entire chapter (Ad Seebregts, Energy research Centre of the Netherlands)	Noted w/com.: change to percent increase in efficiency.
4-273	A	12	25			Please indicate whether efficiencies are based on HHV or LHV. This must be clear in the entire chapter (Daniel Jansen, Energy research Institute of the Netherlands)	“”
4-274	A	12	27			“generated” should be “consumed” (Michael Bowman, GE Global Research)	Accepted without com.
4-275	A	12	43		45	Conclusion is not supported by the Fig. 4.2.2! (Ad Seebregts, Energy research Centre of the Netherlands)	Noted without com.
4-276	A	12	45	12	46	It is proposed to substitute "reduced energy demand" by "improved energy efficiency". (Radunsky Klaus, Umweltbundesamt)	Accepted without com.
4-277	A	12	49	12	52	Delete this sentence. The assertion "Total global energy demand reduction in developed countries is imperative if mankind is to support the socio-economic	Accepted w/com.: the statement is oversimplified and needs a review.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						development of the 2 billion people who at present have limited or no access to electricity …" is unsupported and unjustified. The information previously presented in the chapter indicates large supplies of fossil fuels, more than enough to provide energy services to those who do not have them while maintaining them for those who currently do. The chapter has yet to estimate renewable energy resources, but these also are more than sufficient to meet the needs of both developed and developing nations. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	
4-278	A	12	49	13	3	This statement explicitly sets up the tone pitting the "haves" and the "have nots" into a conflict. IPCC's role should stay true to assessing policy relevant facts, not making facile recommendations taken directly from a literature source (Renewables, 2004). While it is an oft-quoted fact that 2 billion people do not have access to modern enegy, increasing the implementation of renewable energy is not the only answer. It is true that it can aid the achievement of sustainable development goal, but installing expensive solar power panels, for example, may detract from the money available to help build a clinic, a school, etc. This statement should be revised to be consistent with othe sections: "Increasing the implementation of renewable energy, among a portfolio of cost-effective energy technologies, will aid communities to achieve their development goals." (Arthur Lee, Chevron Corporation)	Noted without com.
4-279	A	12	49			Sentence is value-loaden by using the wording 'imperative' (Ad Seebregts, Energy research Centre of the Netherlands)	“”
4-280	A	12	49	12	52	WEO2004 estimeted that about 1.6 billion people in developing countries did not have access to electricity in their homes. 2.4 million people are relying on traditional biomass for cooking and heating purpose with severe health impact. (Fatih Birol, International Energy Agency)	“”
4-281	A	12	49			policy prescriptive (Bert Metz, IPCC)	Accepted without com.
4-282	A	12	50	12	50	The number more often used now is 1.6 billion, but I have been unable to locate an authoritative source for either number.	Noted without com.

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						(Steve Sawyer, Greenpeace International)	
4-283	A	13	3			BIREC, 2005: which specific contribution of this conference? (Ad Seebregts, Energy research Centre of the Netherlands)	“”
4-284	A	13	5	13	5	The exploitation of landfill gas (via energy recovery) usually takes place in relatively large and not isolated communities, since it requires a certain size of population served so that it is economically viable. Renewables and especially wind or solar PVs are more appropriate for isolated communities. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	(16-feb-06) Noted w/com.: If the isolated community is big enough, maybe this source could be cost-effectively used.
4-285	A	13	10			China's 10% renewables target is even more embarrassingly unrealistic than most of these targets (or 15% by 2020), and to suggest it will not be an "easy achievement" is inappropriate. (Michael Jefferson, World Renewable Energy Network/Congresses)	Rejected because it is based on personal judgement only.
4-286	A	13	15			(Zheng, 2005) Personal Communicationsa are not accepted references (not traceable). Other reference? (Ad Seebregts, Energy research Centre of the Netherlands)	Taken into account: trying to obtain other reference.
4-287	A	13	30			It seems to me neccesary add that, the simple access to energy is not synonymous of economic and social evolution in our times. (Ramiro Juan Trujillo Blanco, National Programme on Climate Changes)	Accepted without com.
4-288	A	13	39	14	2	Addional reference: CIEP, 2004: Study on Energy Supply Security and Geopolitics, Final report, Clingendael Internation Energy Programme, Institute for International Relations ‘Clingendael’, The Hague, the Netherlands. (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted without com.
4-289	A	13	39			Energy security is dual and reciprocal, especialy in the affordable fossil energy, energy supply needs huge and irreversible long term investments which require assurances of demand. Therefore the question of energy demand security should be addressed adequately in this chapter. (Mohammed Alfehaid, Saudi Aramco)	Accepted without com.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-290	A	13	43		46	Oil flow in Hormuz Strait in 2004 is 16.5-17.0 mb/d (see EIA/DOE, http://www.eia.doe.gov/cabs/World_Oil_Transit_Chokepoints/Hormuz.html) and in Malacca Strait is 11.7mb/d (see http://www.eia.doe.gov/cabs/World_Oil_Transit_Chokepoints/Malacca.html) (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Taken into account: figures will be updated accordingly.
4-291	A	13	46	13	46	You can refer to our most recent work, World Energy Outlook 2005. (Fatih Birol, International Energy Agency)	Taken into account: figures will be updated accordingly.
4-318	A	14	0			Section 4.2.2. What is the role of this (brief) section on price fluctuations? We know that price fluctuations exist. They have causes and effects. Which relationship is relevant e.g. to mitigation options or costs? (Ad Seebregts, Energy research Centre of the Netherlands)	Noted without com.
4-292	A	14	2	14	2	I miss something on disruption figures, can you indicate the level of security, how has this changed in the past years (Monique Hoogwijk, Ecofys)	Noted without com.
4-293	A	14	5			Section 4.2.2 is too weak now, and needs to be improved. (Wenying Chen, Energy, Environment, and Economics Research Institue, Tsinghua Univerisity)	Taken into account: we're working on that in the new edition of Chapter 4 SOD.
4-294	A	14	5	14	15	This is relevant information. I suggest you expand this section by one or two pages, with quantititative information, may be using a CA. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Rejected: see references.
4-295	A	14	6	14	15	This entire paragraph has generic statements not necessarily backed by data. The most egregious statement is "…the poorest economies suffer most because they annot afford short-term price spikes without reducing the investment budget…" This will highly depend on how they scope and allocate their investment budget. A poor economy may not be suffering "most" if its budget is managed in ways to reduce the effect of such spikes. (Arthur Lee, Chevron Corporation)	Rejected because it is a personal point of view, not backed by data.
4-296	A	14	6	14	15	Is this necessary here? Not very informative and new (Monique Hoogwijk, Ecofys)	Noted without com.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-297	A	14	7			Section 4.2.2 -- Price fluctuations are a vital consideration, and additional detail in this section would be helpful. As it stands, the comments are very superficial. I would like to see detail similar to 4.2.5 Regional Trends, which is quite informative. (Stan Bull, National Renewable Energy Laboratory)	Noted without com.
4-298	A	14	7	14	15	(Radunsky Klaus, Umweltbundesamt)	?? No Comment given
4-299	A	14	7	14	15	RECOMMENDATION: Retitle Section 4.2.2 "Effects of different forms of price uncertainties". JUSTIFICATION: Section 4.2.2 is headed "Effects of price fluctuations", but the text is in fact discussing two difference forms of uncertainties. The fluctuations in price for oil and gas are unavoidable because these commodities are traded in a market. The fluctuations in energy output from most renewables are unavoidable because of the natural variations in the sources of those energies, whether wind, rain or sun. However the uncertainties listed for nuclear energy are uncertainties in the cost of future plant. These uncertainties will, in the main, not affect the price of energy production once the nuclear power plant is in operation. This comment further supports the additional wording proposed in the previous comment. (Jonathan Cobb, World Nuclear Association)	Accepted Suggestions will be considered. Taken into account: we're working on that in the new edition of Chapter 4 SOD.
4-300	A	14	7	14	15	IEA, 2004 World Bank (ESMAP) and Awerbuch 2005a (Exploiting Oil/GDP effect) all raise oil price fluctuation impacts, with ESMAP reporting assessing (and showing) the vulnerability of oil importing low-income economies to oil price change (may also be relevant for 4.2.6 Implications of development). Awerbuch assesses the avoided GDP losses from investing in renewables (or other price-stable sources, including demand side management). it may also be relevant to cross reference with issues raised in 4.6, page 50, discussion on price fluctuation. (Kirsty Hamilton, retainer to UK Business Council for Sustainable Energy; Associate Fellow, Chatham House.)	Taken into account: we're working on that in the new edition of Chapter 4 SOD.
4-301	A	14	10	14	12	RECOMMENDATION: Amend sentence ending in line 12 to read : "...costs of obtaining resource consents, although once in operation nuclear power prices remain relatively stable, despite fluctuations in uranium fuel prices, as the cost of	Accepted Suggestions will be considered. Taken into account: we're working on that in the new

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						uranium fuel represents a much lower fraction of generation costs in comparison to fossil fuels." JUSTIFICATION: The comments on price fluctuations for different energy sources should include mention of those areas where one energy source does not have the same disadvantage of another. In the case of nuclear power the cost of electricity is not affected by variations in uranium fuel prices to the degree that is the case for fossil fuels because the cost of uranium fuel is a relatively small part of the overall cost of generation. An example of the differences in the contribution made by fuel costs to overall generation costs is given on page 22 of Impact of U.S. Nuclear Generation on Greenhouse Gas Emissions Ronald E. Hagen, John R. Moens, and Zdenek D. Nikodem. Energy Information Administration U.S. Department of Energy. Available at http://tonto.eia.doe.gov/FTPROOT/nuclear/ghg.pdf (Jonathan Cobb, World Nuclear Association)	edition of Chapter 4 SOD.
4-302	A	14	11	14	11	Financial markets are Not unwilling to invest - but may command a higher interest rate to cover precieved risks thus increasing the cost of capital and prices nuclear out of the market. (H-Holger Rogner, IAEA)	Noted; cf. comment 4-220 and response to it. The market situation is region- and case-specific. Taken into account: we're working on that in the new edition of Chapter 4 SOD.
4-303	A	14	14	14	15	RECOMMENDATION: Line 15 should continue "Equally, variations in the carbon trading price will also affect energy prices, especially those of fossil fuels." JUSTIFICATION: The text states that "Varying energy prices will also affect the carbon trading price." However, the main body of this chapter is discussing price fluctuations in energy prices. Where emissions trading includes the power generation sector, as in the EU ETS, there is the potential for carbon allowances prices to have a significant influence on energy prices. (Jonathan Cobb, World Nuclear Association)	Accepted Carbon trading price is a factor worth of discussing. Taken into account: we're working on that in the new edition of Chapter 4 SOD.
4-304	A	14	18			Section 4.2.3 should not only focuses on primary energy consumption amount and its mix, but also to discuss coal, oil, gas industry as well as power industry development trends. (Wenying Chen, Energy, Environment, and Economics Research Institue, Tsinghua Univerisity)	Rejected because personal preferences.

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4-305	A	14	18	14	44	Duplication with Chapter 1 plus the use of different data sources (IEA vs Enerdat - mostly based on IEA) introduces inconsistencies. (H-Holger Rogner, IAEA)	Taken into account: we're working on that in the new edition of Chapter 4 SOD.
4-306	A	14	23			Figure 4.2.2. Check figure format (Marco Mazzotti, Institute of Process Engineering)	Taken into account: we're working on that in the new edition of Cahpter 4 SOD.
4-307	A	14	31			Figure 4.2.3. The firuge could be improved by inserting the names of the geographical areas in the colored belts. The relative growth rate in each area between 1990 and 2004 could also be given after the name of the area (e.g. Asia 5%/a). (Ilkka Savolainen, Technical Research Centre of Finland VTT)	Use 4.1.1 or 4.2.3.
4-308	A	14	31			"Figure 4.2.3":It would be appropriate to use IEA statistics which is compiled through energy-balance format and has been widely cited as a result. Please find attached file "Fig4.2.3.xls", using IEA Energy Balances. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Accepted we'll examine the differences.
4-309	A	14	31			Fig. 4.2.3: I suggest to use of max 4 significative numbers (Stefano Caserini, Politecnico di Milano)	Noted, but don't understand the comment; figures have only three significant numbers.
4-310	A	14	34			Figure 4.2.4. Order in legend should be altered somewhat to match better with lines displayed (Ad Seebregts, Energy research Centre of the Netherlands)	Noted without com.
4-311	A	14	34		36	According to IEA energy balance statistics, total share of fossil fuels dropped from 86% in 1971 to 80% in 2003 (see also Fig4.2.4.xls) (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Noted: reference will be added.
4-312	A	14	40			"Figure 4.2.4": I recommend using IEA statistics which is compiled through energy-balance format and has been widely cited as a result. Please find attached file "Fig4.2.4.xls", using IEA Energy Balances. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	""
4-313	A	14	40	14	44	Tab.e 4.2.1 and 4.2.2 as regards the relative shares of hydro and nuclear. Their electrical output is nearly the same, and WEO 2004 (IEA 2004) has them exactly the same on page 198. UNDP's World Energy Assessement - 2004 update	Accepted The normal IEA practice is followed. Footnote to the practice will clarify the

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						(http://www.undp.org/energy/weaover2004.htm) suggests that if one includes small hydro, that hydro is slightly larger in terms of Twh produced. So why not make them equivalent in primary energy terms as well, by fixing them one way or the other, rather than suggesting as table 4.2.1 does that nuclear supplies more than 3 times as much power as hydro which it patently does not? (Steve Sawyer, Greenpeace International)	information given regarding nuclear vs hydro The TWh figures could be presented in parallel.
4-314	A	14	40			Figure 4.2.4 The choice of colors in the figure makes it unclear (Marco Mazzotti, Institute of Process Engineering)	Accepted without com.
4-315	A	14	42			Table 4.2.1. Not to table should metion the EJ 'fossil equivalent' (FEQ) of e.g. nuclear and some of renewables. Some statistical conventions use a '0' here, rather than FEQ (Ad Seebregts, Energy research Centre of the Netherlands)	cf. comment 4-313. Rejected: too much detailed.
4-316	A	14	42			"Table 4.2.1": I recommend using IEA statistics which is compiled through energy-balance format and has been widely cited as a result. Please find attached file "Table4.2.1.xls", using IEA Energy Balances. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Noted: will be examined.
4-317	A	14	47	15	2	There a large number of 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)	Taken into account: we're working on that in the new edition of Chapter 4 SOD.
4-319	A	15	4			"Table 4.2.2": In order to deal with IEA outlook in a consistent way, I recommend using IEA statistics, as actual data 1971-2003, which is compiled through energy-balance format and widely cited. Please find attached file "Table4.2.2.xls", using IEA Energy Balances. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Noted: will be examined.
4-320	A	15	5		6	Please provide an indication for fraction 'not renewable' in waste (Ad Seebregts, Energy research Centre of the Netherlands)	Rejected because "not renewable" refers to biomass, fuels and wastes.
4-321	A	15	13	15	13	Is it 1.8% of electricity coming from solar ? (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted without com.

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4-322	A	15	14			Fig. 4.2.2 gives the useful light outcome, but a note on the comparison of this with fluorescent lighting might be educational. (Michael Jefferson, World Renewable Energy Network/Congresses)	Taken into account: will be added the nature of the light lamps taken for comparison.
4-323	A	15	14		18	I propose to explicitly add the evidence of considerable increase in electricity demand particularly in Asian region countries, and I would appreciate if adding the figure. Please see slide number "38" of attached file "ITO.ppt" (Source: Ito K, 2004, ASIA/WORLD ENERGY OUTLOOK Burgeoning Asian economies and the changing energy supply-demand structure, The Institute of Energy Economics, Japan (IEEJ),http://eneken.ieej.or.jp/en/index.html) (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Taken into account: we're working that in the new editon of Chapter 4 SOD.
4-324	A	15	16			IEA, 2002: which 2002? (may occur more than once, not mentioned repeatedly (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted without com.
4-325	A	15	21	16	26	Change MtCO2_eq to MtC_eq (H-Holger Rogner, IAEA)	Accepted without com.
4-326	A	15	21			use unfccc reports, eea reports for emission data; show energy efficiency also in PPP and in E/ unit of product (in some sectors developing countries have the most efficient plants); also projections (Bert Metz, IPCC)	Accepted without com.
4-327	A	15	32			"Figure 4.2.5": I recommend using IEEJ(The Institute of Energy Economics,Japan) statistics, clearly compiled from IEA statistics. Please find attached file "Fig4.2.5.xls". (Source: IEEJ, 2005, Handbook of energy & economic statistics in Japan, The Energy Data and Modelling Centre, Institute of Energy Economics, Japan.) (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Taken into account: we're working on that in the new edition of Chapter 4 SOD.
4-328	A	15	32	15	32	Fig. 4.2.5: Africas present emissions are surely not above 20 billion tons. I suppose the diagram was intended to be layer-formatted, not line-formatted. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accepted without com.
4-329	A	15	39		40	It would be better to add CO2 emissions outlook in China for 2030. Please see	Taken into account: we're working in that in

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						Table 3-9, page 13 of attached file "Li Z.doc".(Source: Li Z, Ito K and Komiyama R, 2005, Energy Demand and Supply Outlook in China for 2030 and A Northeast Asian Energy Community - The automobile strategy and nuclear power strategy of China -, The Institute of Energy Economics, Japan (IEEJ),http://eneken.ieej.or.jp/en/index.html) (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	the new editon of Chapter 4 SOD.
4-330	A	15	39		40	According to the latest IEEJ statistics, "From 1990 to 2002 China's carbon dioxide emissions increased from 676 MtC to 953MtC to be-come 14.5% of global emissions".(Source: IEEJ, 2005, Handbook of energy & economic statistics in Japan, The Energy Data and Modelling Centre, Institute of Energy Economics, Japan.) (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Taken into account: data will be examined.
4-331	A	15	40	15	42	Modify the last sentence to "Continuous efforts on technical progress towards energy efficicency improvement, development of new and renewable energy, as well as structure adjustment however have led to a decline in carbon intensity at annual decrease rate of 5% during 1980 to 2000, and is expected to be 3% in the next 50% years (2000-2050). (Literature "The costs of mitigating carbon emissions in China: findings from China MARKAL-MACRO modeling (CHEN Wenying, Energy Policy 33 (2005) 885–896)")." Future carbon emission reduciton in China not only rely on energy technology efficiency improvement, but also highly depend on future economic structure adjustment (decreasing share of industry while increasing share of service sector), industry sector's structure adjustment (increasing share of light industy, and increasing share of high-value added products), and development of new and renewable energy. Past development experience in China showed that technology efficiency improvement contributed to around 1/3 while structure changes contributed 2/3 to the overall energy efficiency(energy intensity) improvement. ") (Wenying Chen, Energy, Environment, and Economics Research Institue, Tsinghua Univerisity)	Accepted without com.
4-332	A	16	4	16	16	"UNFCC" should be "UNFCCC"	Accepted without com.

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						(Wenying Chen, Energy, Environment, and Economics Research Institue, Tsinghua Univerisity)	
4-333	A	16	18			In this section (4.2.5), only Asia-Pacific region and EIT region are taken up. Other regions also should be mentioned. (Kenichi Oshima, Ritsumeikan University)	Accepted w/com.: Will try to obtain the information.
4-334	A	16	24	16	26	Nitrous oxide, N2O, is a GHG, one of the six gases or families of gases controlled by the Kyoto Protocol. It should be referred to in the singular. Oxides of nitrogen refer to NO and NO2, both of which are ozone precursors. N2O is emitted during low temperature combustion, NO during high temperature combustion. Referring to nitrous oxides confounds these different gases, all of which are of concern in the climate context. The authors need to be clear as to which of the gases they mean. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted without com.
4-335	A	16	24			Section 4.2.4.3 needs to be improved. (Wenying Chen, Energy, Environment, and Economics Research Institue, Tsinghua Univerisity)	Accepted without com.
4-336	A	16	24		26	Section 4.2.3.3 Please provide figure in text for nitrous oxides emissions in Mton CO2-eq (Ad Seebregts, Energy research Centre of the Netherlands)	Noted without com.
4-337	A	16	25	16	26	Section 4.2.4.3 should be deleted or (preferably) expanded. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Noted without com.
4-338	A	16	26			USEPA, 2005 not in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted without com.
4-339	A	16	29			do not separate regional data from overall picture; integrate (Bert Metz, IPCC)	Accepted without com.
4-340	A	16	30	17	7	In this section increasing concern about political and societal situations in Middle Eastern countries, such as Iraq, Iran, Saudi Arabia, should be mentioned relating to the energy security of Asia-Pacific region. (Ryota OMORI, Japan Science and Technology Agency)	Accepted without com.
4-341	A	16	32	16	33	The largest source of primary energy comsunption in the Asia-Pacific region is still	Rejected because Table shows precisely this

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						coal. It is not oil as shown in Table 4.2.3. (Ryota OMORI, Japan Science and Technology Agency)	about coal.
4-342	A	16	39	16	39	Based on China's published statistics book (National statistics Abstract 2005), the annaual GDP growth rate during 1990-2003 is as high as 9.67% instead of 4.5% mentioned here. This number (4.5%) must be wrong. (Wenying Chen, Energy, Environment, and Economics Research Institue, Tsinghua Univerisity)	Accepted without com.
4-343	A	16	39		42	(Content is the same as the above line) Among the countries over the world, China shows the most increasing for the future. It is better to emphasize this point.Please see Figure 6,page 20 of attached file "183-210.pdf", which original graph in "Fig6.xls".(Source: Komiyama, R., Li, Z. and Ito, K. (2005) `World energy outlook in 2020 focusing on China's energy impacts on the world and Northeast Asia', Int. J. Global Energy Issues, Vol. 24, Nos. 3/4, pp.183-210.). Figure 6 is about incremental increase in world primary energy consumption by energy source and by region from 2000 to 2020. China has larger impact over the international energy market for the future. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	“”
4-344	A	16	39	16	39	Growth rate based on purcasing power parity (ppp) or market exchange rates (mex).If mex then therate appears low. (H-Holger Rogner, IAEA)	Accepted w/com.: we’ll look bases for growth rate.
4-345	A	16	42	16	44	The statement " … 70% of particulate emissions, 90% sulfur dioxide, …" should cite a reference. Is it the same reference as in the previous statement (BP, 2004)? (Arthur Lee, Chevron Corporation)	Accepted w/com.: we’ll find reference.
4-346	A	16	43	16	44	To what do percentages refer to? What is the total?) (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Accepted w/com.: we’ll add “in China” at the end of sentence.
4-347	A	16	49		50	I recommend also adding the fact that China become net importing countries of petroleum products since 1992, and of crude oil since 1996, based on source	Accepted without com.

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						"National Bureau of Statistics of China, China Statistical Yearbook" (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	
4-361	A	17	0			Figure 4.3.1 - Figure is unclear. What is "sufficiency" and how is it measured? What is the missing label on the y-axis? (Stan Bull, National Renewable Energy Laboratory)	Accepted w/com.: the figure is redone with Table 4.3.1
4-362	A	17	0			This Figure needs more clarification.Comments on the Figure are as given below: 1. The units and scale for annual consumption given in the legend box and the values written along the X-axis are creating ambiguity. 2. The current consumption value mentioned for natural gas (90 EJ/yr) is inconsistent with the values given in Table 4.5.3 and the value mentioned on page 23, line 7 of sectiuon 4.3.1.1.2. The value of current consumption given in Table 4.5.3 is 100 EJ/year while the value for natural gas only(excluding LNG) as mentioned on page 23, line 7 of section 4.3.1.1.2 is 165EJ/year. 3. Similarly, the present consumption of coal (90 EJ/yr) mentioned along X-axis of the figure while the the same value is given as100 EJ/yr in Table 4.5.3 and in line 23 of page 20 of section 4.3.1.1. 4. As the area of the bars represents the reserve size, therefore any change in their width will also have impact on the height of the bars. (Muhammad Latif, Pakistan Atomic Energy Commission)	Noted see comment 4-361.
4-348	A	17	1	17	1	"Clean-buring natural gas and the emergence of new technologies(including renewable energy will play…." needs to be revised to "clean coal technology(or clean-buring coal), subsitution to natural gas, and emergence of new technology(including renewable energy will play…..". (Wenying Chen, Energy, Environment, and Economics Research Institue, Tsinghua Univerisity)	Accepted without com.
4-349	A	17	1	17	3	Do new technologies also include nuclear? (H-Holger Rogner, IAEA)	Accepted; nuclear power could be a further example
4-350	A	17	1	17	15	RECOMMENDATION (1): Modification of Line 1 to read "Clean-burning natural gas, nuclear and the emergence of new technologies (including renewable…". RECOMMENDATION (2): Addition to the end of Line 15 of the following -	Accepted The references will be considered as well and cited also in section 4.3.2 (e.g. replacing a

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						"However, in China there are proposals for over forty new nuclear reactors with a total capacity of 41-46 GWe by 2020. In India eight reactors are under construction, with plans for 20 GWe of nuclear capacity by 2020". Sources: World Nuclear Association; for China http://www.world-nuclear.org/info/inf63.htm and Nicole Dellero, Franck Chessé, AREVA, New Nuclear Plant Economics, IYNC 2006 conference, Stockholm, Sweden – Olkiluoto, Finland, 18–23 June 2006 Paper No. 234); for India - http://www.world-nuclear.org/info/inf53.htm. and (Reference; R. Mago (Nuclear Power Corporation of India Ltd), Nuclear Power-an option to meet the long term electricity needs of the country, 19th Energy Congress, Sydney, September 5-9, 2004". JUSTIFICATION: At present this section on trends in the Asia-Pacific region does not give a balanced report on the growth of nuclear energy in this area. It does, in Line 12, note that nuclear energy plays an important role in electricity generation. However, by only reporting the short term reduction in planned nuclear reactors in Japan it does not report with sufficient breadth the growth of nuclear energy in the Asia-Pacific region as a whole. (Jonathan Cobb, World Nuclear Association)	reference New York Times !) The text on the situation in Japan will be clarified as well.
4-351	A	17	12	17	15	This part gives impression that all Asian countries will withdraw nuclear energe. Chinese government plans to expand nuclear power capacity. This remarkable movement should be referred here (though it is refered in the fifth paragragh of Section 4.3.2). China has nine nuclear power reactors in operation and a further two units under construction. Additional reactors are planned, to give a fivefold increase in nuclear capacity to 40 GWe by 2020 (http://www.world-nualear.org/info/inf63.htm). (Ryota OMORI, Japan Science and Technology Agency)	Accepted; cf. response to comment 4-350
4-352	A	17	12	17	15	Electricity demand in Japan is expected to reach its peak along with its decrease of population in the long-term. The Japanese official long-term energy forecast says that the total energy demand will reach its peak in 2021 and will decrease thereafter. In addition, almost all nuclear power plants in Japan are expected to be decommissioned around 2050. (Kenichi Oshima, Ritsumeikan University)	Noted; cf. comments 4-350, 4-351, 4-353 and response to them

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-353	A	17	13		15	Additionally to say, Japan's additional nuclear power plant from 2010 to 2030 is 6 plant and total nuclear capacity evolves from 50GW in 2010 to only 58GW in 2030 reflecting on sluggish increase in electricity demand based on promoting of energy conservation and depopulation from 2006.(Source: Ministry of Economy, Trade and Industry(METI),March 2005,Japan's Energy Outlook for 2030 (Japanese)) (Please see pp.96 of attached file "Japan's Energy Outlook 2030.pdf") (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Accepted; cf. response to comment 4-350
4-354	A	17	13	17	15	The description there may make a wrong impression that Japan's policy on nuclear power is shrinking. So "...but palnts for the ... 45GW to 50GW in 2010" should be changed "Japan puts it at the core of its energy policy. As of 1/1/2006 in Japan 54 nuclear reactors are in operation. And 2 among planned 14 reactors will be on line before 2010." (Shigeo Murayama, The Federation of Electric Power Companies)	Accepted; cf. other comments to the same topic
4-355	A	17	14	17	15	As mentioned here, Japan's NPP construction plan has been scaled down. However it should be noted that this does not mean the decrease in nuclear power capacity in Japan. On October 14th, 2005, Japan Atmic Energy Commission published 'Framework for Nuclear Energy Policy' that Japanese government decided to respect in energy policy making. The report states that it is appropriate to aim at maintaining or increasing the current level of nuclear power generation (30 to 40% of the total electricity generation) even after 2030. (Ryota OMORI, Japan Science and Technology Agency)	Accepted; cf. other comments to the same topic
4-356	A	17	17		23	It is better to compare energy demand growth of Asia with another region in order to emphasize it. I propose to add Figure 3, page 10 of attached file "183-210.pdf", which original graph in "Fig3.xls", and to add Table 10, page 21 of same attached file, original table in "Table10.xls". (Source: Komiyama, R., Li, Z. and Ito, K. (2005) `World energy outlook in 2020 focusing on China's energy impacts on the world and Northeast Asia', Int. J. Global Energy Issues, Vol. 24, Nos. 3/4, pp.183-210.) Figure3 is about incremental increase in world primary energy consumption by region from 2000 to 2020, and Table10 is primary energy consumption growth by region and energy source.	Noted we'll look at proposed figure and Table

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	
4-357	A	17	17		23	It is better to add the reason why Asia-Pacific region shows astounding energy demand growth. Among energy sources, oil demand is projected to represent the most considerable growth both in the world and Asia. This reason is based mainly on the promotion of motorization particularly in developing Asia. I propose to add Table 11, page 22 of attached file "183-210.pdf", which original graph in "Table11.xls". (Source: Komiyama, R., Li, Z. and Ito, K. (2005) `World energy outlook in 2020 focusing on China's energy impacts on the world and Northeast Asia', Int. J. Global Energy Issues, Vol. 24, Nos. 3/4, pp.183-210.) (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	“”
4-358	A	17	17		23	It is better to add about energy demand growth outlook by both sector and enery source in order to understand which sector drives energy demand increase. I recommend adding Figure 5, page 12 of attached file "183-210.pdf", which original graph in "Fig5.xls". It represents incremental fossil fuel consumption in the world and China by sector from 2000 to 2020.(Source: Komiyama, R., Li, Z. and Ito, K. (2005) `World energy outlook in 2020 focusing on China's energy impacts on the world and Northeast Asia', Int. J. Global Energy Issues, Vol. 24, Nos. 3/4, pp.183-210.) (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	“”
4-359	A	17	25	17	25	delete "for all its long-term rewards", as it is an unnecesary political statement. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted without com.
4-360	A	17	48	17	50	RECOMMENDATION Reword beginning of sentence starting at Line 48 to read "Renewable energy, nuclear energy and energy efficiency can play...". JUSTIFICATION: A number of Central and Eastern European countries have plans for expansion of their nuclear energy capacity. This can help reduce reliance on fossil fuel imports and improve the environment. Source: World Nuclear Association http://www.world-nuclear.org/info/reactors.htm; http://www.world-nuclear.org/info/inf45.htm (Jonathan Cobb, World Nuclear Association)	Accepted
4-363	A	18	7			"Carbon emission trading" should be changed to "international carbon emission	Accepted without com.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						trading". It is more consistent with the sentence above(line 2) that refers to international cooperation. (Shinichi Nakakuki, Tokyo Electric Power Company)	
4-364	A	18	11	18	35	Why do you not take the SRES figures. There should be a handshake between chapter 3 and the sectoral chapters, therefore it was decided to use the SRES scenarios. Comparison with WEC and IEA might be interesting, but SRES should also be included otherwise there is no consistency (Monique Hoogwijk, Ecofys)	Accepted add a SRES reference. Accepted. Use A1B and B2 SRES Scenarios at least.
4-365	A	18	15			I suggest that "quality of life" be replaced with the more specific "materila standard of living" as there can be considerable debate about the role on material standrad of living in quality of life. Changinmg the phrase bypasses that challenge. (Roger Gifford, CSIRO)	Noted without com.
4-366	A	18	19			You don't provide a reference for the 4%/yr growth rate. However, I checked the PPP data in "Vital Signs 2005" (WorldWatch Institute), and computed the average growth rate as 3.8%/yr for the period 1950-2004. This is a useful reference to cite. It would also be useful to cite the following, which I computed from the Vital Signs GDP/P data: GDP/P grew at a rate of about 2.9%/yr during the 1950s and 1960s, 1.9%/yr in the 1970s, 1.4%/yr in the 1980s, and 1.6%/yr in the 1990s. Thus, growth rates of GDP/P have been falling, and combined with slower population growth (and eventual pop stabilization), implies slower growth rates in the future. Thus, 4%/yr is unlikely as a long term projection for the future (which may be why the scenarios assume 1-3%/growth over the long term). (Danny Harvey, University of Toronto)	Noted good comment. Accepted. Change to lower growth rate and locate the reference (Try world Bank, rtc)
4-367	A	18	21			WEC, 2004: which 2004? (may occur more than once, not mentioned repeatedly (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted w/com.: the reference is 2004b or 2004d. Thanks. Let be careful in accounting references.
4-368	A	18	27	18	28	"… to build power production facilities." I believe that power production is not the only need here. In many regions of the world, in San Francisco, in New York, in Italy, there are bottlenecks in transmission. The statement should add " … and transmission facilities."	Accepted without com. Complement sentence “”transmission system and distributed generation”.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Arthur Lee, Chevron Corporation)	
4-369	A	18	30			uranium mining also poses ecological implications (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted w/com.: we need to add conversion systems to the sources. Add uranium.
4-370	A	18	30	18	31	It is necessary to add other ecological implications of energy supply. At least, it is required to add ecological implications by fossil fuels combustion, radioactive emission from nuclear facilities and uranium mining. (Kenichi Oshima, Ritsumeikan University)	Noted without com. Partially accepted using Comment 369 reply
4-371	A	18	35			table 4.2.4. Not referenced in the text (Ad Seebregts, Energy research Centre of the Netherlands)	Noted without com. Accepted. Mention Table 4.2.4 around lines 18-21 but consider using SRES Scenarios instead of WEC and IEA.
4-372	A	18	35	18	35	This is from "Energy to 2050", which was published in 2003. (Fatih Birol, International Energy Agency)	Accepted. Use this reference. “”
4-373	A	18	38	58	50	It is difficult to find your way in section 4.3, 4.4 and 4.5, due to a structure that first goes over all energy sources, then deals with specific technologies related to conversion, and then goes into mitigation costs and potentials. For the reader it would make sense to reorder the text in a way that per energy source you deal with developments and mitigation options in one section. At the very end an overview section like 4.5.5 would provide the comparative summary of mitigation potentials and costs over all energy resources. (Peter Bosch, IPCC TSU WGIII)	Page 9 is misplaced. Keep technology discussion first and the go to Mitigation Options. Reduce technology discussion.
4-374	A	18	44			Rotty, 1994 reference is incomplete in list (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted. Let us check
4-375	A	19	8			Bradley, 1999 not in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Thanks.
4-376	A	19	8		11	Among the countries over the world, China shows the most increasing for the future. It is better to emphasize this point.Please see Figure 6,page 20 of attached file "183-210.pdf", which original graph in "Fig6.xls".(Source: Komiyama, R., Li, Z. and Ito, K. (2005) `World energy outlook in 2020 focusing on China's energy impacts on the world and Northeast Asia', Int. J. Global Energy Issues, Vol. 24,	Rejected. Short in space and thereis already a lot of information about China in the text.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						Nos. 3/4, pp.183-210.). Figure 6 is about incremental increase in world primary energy consumption by energy source and by region from 2000 to 2020. China has larger impact over the international energy market for the future. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	
4-377	A	19	8		11	(Content is the same as the above line) It is better to compare energy demand growth of Asia with another region in order to emphasize it. I propose to add Figure 3, page 10 of attached file "183-210.pdf", which original graph in "Fig3.xls", and to add Table 10, page 21 of same attached file, original table in "Table10.xls". (Source: Komiyama, R., Li, Z. and Ito, K. (2005) `World energy outlook in 2020 focusing on China's energy impacts on the world and Northeast Asia', Int. J. Global Energy Issues, Vol. 24, Nos. 3/4, pp.183-210.) Figure3 is about incremental increase in world primary energy consumption by region from 2000 to 2020, and Table10 is primary energy consumption growth by region and energy source. (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Rejected. We already have discussed this point and space limitation precludes long detailed discussion.
4-378	A	19	15			Table 4.3.1 gives only one estimate of the conventional oil resource. USGS gives three, although the 'high' is so high that only one source in the literature provides the same or higher figure. It is suggested that a Table showing the range with comment might be useful (Hall, 2003, provides a listing published in 'Nature').Similar comments might go for natural gas, and unconventionals. The wind figure seems too high to be a representative figure. (Michael Jefferson, World Renewable Energy Network/Congresses)	Accepted. Let us add footnote for each of the figures telling there are higher and lower estimates as quoted by ‘add some other references’.
4-379	A	19	15	19	17	The "Cost" column in Table 4.3.1 includes various units and mixes cost for both energy sources (e.g. conventional oil, $40 - $70/bbl) and energy carriers (e.g. cost for biomass is presented in cents/kWh). The table would be more useful if it used consistent units and included 2 columns: 1) "Cost of Primary Source" and 2) "Cost of Energy Product". Not all sources would have entries for the first (e.g. solar, nuclear, etc), and some fuels would have multiple entries for energy products (e.g. coal as electricity and liquid & solid fuels). (Lee Lynd, Dartmouth College)	Accepted; need for clarification acknowledged. Sounds a good suggestion. Let us add cents/kWh for all sources and state the efficiency of conversion .
4-380	A	19	15			Table 4.3.1. It would help if "conventional" and "unconventional" were explained	Accepted. Add a footnote suggesting to look

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						here (e.g. in footnotes) (Matti Melanen, Finnish Environment Institute)	in the Glossary.
4-381	A	19	15			In Table 4.3.1, the estimated amount of biomass energy available is 250 EJ/yr. This figure does not indicate how much would be used for heat/power and how much processed to produce liquid fuels. (The proportions matter because of large differences in conversion efficiency, and therefore the amount of land required per EJ/yr.) Even if all of the biomass were used for heat, the land requirement, at an average of 33,000 km^2 /EJ/yr, would be 8,250,000 km^2, an amount that could cause serious difficulties with other uses of land, particularly agriculture.Even more serious in terms of resource use, biomass is likely to be a very large user of water. Bernedes (Global Environmental Change, 2002) demonstrates that large scale biomass might consume as much water as agriculture, the largest user of ground /surface water currently requires. As water is a resource that may well be in short supply as the 21st century progresses, it is important to consider the demands on water availability, as well as land, if large scale biomass is to be considered an energy crop.In presenting biomass energy figures it is important to distinguish between gross and net energy. A large amount of energy is required to plant, fertilize, harvest, and transport energy crops. Some estimates are provided by Cassedy (2000). But even more serious are the implications of conversion to liquid fuels. A recent paper by Pimentel and Patzek, (Natural Resource Research, 2005) estimates the energy inputs into ethanol (from corn, switchgrass, and wood) and into biodiesel (from soybeans and sunflower) exceed the energy output of the ethanol/biodiesel. If so, then net energy from biomass is actually negative. If true, biomass cannot be much help, if any, in stabilizing climate. As with the water consumption issue, the net/gross energy issue is one that the Report cannot ignore. (Christopher Green, McGill University)	Partially accepted. I don't think we have to make Table 4.3.1 too complex. But the results on the references quoted regarding energy balances should be reported and analysed in the text.
4-382	A	19	15			In Table 4.3.1 we are told that "estimated available energy" is, in the case of wind, 600 EJ/yr. There is no explanation of how the 600 EJ/yr estimate is calculated. However, the estimate is similar to the one in WG III TAR (chapter 3), an estimate that was seriously flawed. Here is why I think the 600 EJ/yr figure is flawed. In the	Rejected. We have to rely in available literature. We must consider Lightfoot and Green paper 2002; Eliasson, 1998 for this discussion.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						TAR, it is reported that there are 30,000,000 km^2 of land with average wind speeds of at least 5.1 m/s-the minimum value for effective use of wind energy. The TAR also indicated that perhaps an average of 4% of this land could be used for wind farms. (It is not clear how much offshore siting, where there are very gently sloping shelves, would add.) These estimates imply that about 1,200,000 km^2 could be used for wind farms (assuming public acceptability). It takes an average of about 20,000 km^2 (Lightfoot and Green, 2002; Eliasson, 1998) to produce an EJ/yr of electricity at 25% capacity utilization. This works out to 60 EJ/yr (1,200,000 km^2 / 20,000 km^2), an order of magnitude less than is reported in Table 4.3.1. Even if the 20,000 km^2/EJ/yr figure were too high by an order of 2, that would yield 120 EJ/yr-or 20% of the Report's 600 EJ/yr estimate. At the very least, the authors should indicate how the estimates it reports are calculated. There are persons who glibly (and unknowingly) repeat IPCC estimates of solar and wind energy, as if these were accurate, achievable, and practical. But are they in any of these respects? (Christopher Green, McGill University)	
4-383	A	19	15	9	15	The row for fusion in Table 4.3.1 is 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 - 10c/ kWh(e) / Comments on environmental impacts: Small / References: R. Keith Evans, "Lithium reserves and Resources", Energy, 3, 379-385 (1978) ------- "Unlikely for decades" is not a "Comment on environmental impacts". (Robert Goldston, Princeton Plasma Physics Laboratory)	Accepted, but regarding cost add a footnote that this is the expected value but since technical feasibility is far away cost is too uncertain.
4-384	A	19	15	19	17	Table 4.3.1: How do you compare the energy ressources of coal, biomass etc. with electricity production (hydro, wind, etc.). 1 J(el) = 1 J (th)? Or something other? Please note. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accepted. Add a note describing assumed efficiencies.
4-385	A	19	15			Table 4.3.1	Taken into account

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						• Figures of energy available in uranium present in earth's crust or seawater are based on fallacious assumptions: uranium resources are not the same as energy resources. The energy required to extract uranium from rock rises exponentially with decreasing ore grade. Deposits with grades of 0.01% uranium or lower cannot be considered energy resources, because the extraction of one kilogram of uranium consumes as much energy as can be generated from that kilogram, see Appendix A. • Environmental impacts: only spent fuel disposition mentioned. Lacking from the table are impacts such as: - emission of carbondioxide (see Appendix B), - emission of other greenhouse gases (see Appendix B), - emission of radioactive substances, such as: tritium, carbon-14, radioactive noble gases; health, environmental and climatological effects of these routine emissions are probably not well investigated; these effects will aggravate when nuclear power gets a larger share in the world energy supply and consequently the emissions grow to a multiple of the current levels - hazards posed by mill tailings: mobilization of large amounts of radioactive gases (radon) and other radionuclides - risks of spent fuel storage: vulnerability to dilapidation, accidents, terrorism, - reprocessing plants pose a scala of risks to society on their own, - dismantlings wastes, illegal trade of radioactive materials of unknown composition, - social and political stability needed to maintain nuclear facilities and to complete nuclear projects for more than a century; start-up of a nuclear power plant today means finishing the aftermath a century from now. Note: the Appendices A-G are not included in this document and will be sent on request. These comments are based on the study Nuclear power – the energy balance, by J.W. Storm van Leeuwen and Ph.B. Smith, see www.stormsmith.nl Appendix A Energy requirements of extraction of uranium from conventional ores. Dependency on ore grade. Net energy available in the currently known recoverable conventional	The uranium figures in Table 4.3.1 do not include unconventional resources (neither those dissolved in seawater nor by-products in phosphate ores) Further limiting factors (beyond spent fuel disposal) are discussed in section 4.3.2. See also responses to specific comments on that section. Partially accepted. Check reference provided since we must base our analysis on published literature. Also, we must keep Table short in order to be useful. No space to add all the attributes you asked for

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						ores. Appendix B Emission of carbon dioxide and other greenhouse gases from the nuclear electricity generation system. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	
4-386	A	19	15			Figure 4.3.1 Year? Source? Ambiguous figure, purpose is not clear. In my opinion it is not helpful to clarify the (potential) share of the cited resources of the world energy supply, and should be omitted from AR4. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Noted The figure is intended as an additional illustration; in final version data will be chosen as consistent with data presented in tables/text of this chapter. Furthermore, a new version will be prepared to replace the computational corruptions involved). Partially accepted. Add Year and Sources. And improve figure and caption. Check accuracy of figure..
4-387	A	19	17			IAEA, 2004 not in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Thanks.
4-388	A	19	20			Scetion 4.3.1.1 should change to section 4.3.2, and section 4.3.2 to 4.3.3, 4.3.3 to 4.3.4, 4.3.4 to 4.3.5. Under section 4.3.2 Fossil energy, there are 4.3.2.1 coal and peat, 4.3.2.2 methane fuels, 4.3.2.3 petroum, and 4.3.2.4 carbon capture and storage. (Wenying Chen, Energy, Environment, and Economics Research Institue, Tsinghua Univerisity)	Accepted
4-389	A	19	20	27	41	A hodgepodge of energy units => use of SI is recommended throughout the chapter & report. (H-Holger Rogner, IAEA)	Accepted.
4-390	A	19	23			inconsistent with page 14, line 35 (Bert Metz, IPCC)	Accepted. Check which one is good. Review figures extracted from IEA 2003 since CO2 fraction looks too high.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-391	A	19	27	19	29	"Remaining reserves ... are enough to last for decades. Undiscovered resources extend these projections even further." This optimism can only be maintained by using USGS as data basis, see above. Please skip this over-optimistic tendency in the chapter. (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Accepted. Change 'remaining reserves of oil are enough to last for 3 decades at present consumption rate and gas may last a little more'.
4-392	A	19	27	19	17	Annual rates of growth are not very meanigful. They can be affected by economic cycles, price effect etc. Growth rates should be calculated on a longer time period. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accepted. Consider deleting sentence on line 27.
4-393	A	19	28			The remaining reserves of oil and gas are NOT enough to last for "many decades". See your own figure 4.3.1. (Stan Bull, National Renewable Energy Laboratory)	Accepted. See 391.
4-394	A	19	29	19	29	I looked carefully at the Table 4.3.1 anad also Fig 4.3.1. Fig. 4.3.1 Has inconsistent numbers 90 EJ/year for gas versus the 100 EJ/year actually written in Table 4.3.1. Overall, there needs to be a scrubbing of the datasets, in the numbers presented, that come from WEC and BP. (Arthur Lee, Chevron Corporation)	Accepted. Check consistency. Review figure 4.3.1
4-395	A	19	31		32	The reason of oil demand growth is based mainly on the promotion of motorization particularly in developing Asia. I propose to add Table 11, page 22 of attached file "183-210.pdf", which original graph in "Table11.xls". (Source: Komiyama, R., Li, Z. and Ito, K. (2005) `World energy outlook in 2020 focusing on China's energy impacts on the world and Northeast Asia', Int. J. Global Energy Issues, Vol. 24, Nos. 3/4, pp.183-210.) (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	Rejected. Shortage of space and too much information on China in this text.
4-396	A	19	31		32	(Content is the same as the above line)It is better to add about energy demand growth outlook by both sector and enery source in order to understand which sector drives energy demand increase. I propose to add Figure 5, page 12 of attached file "183-210.pdf", which original graph in "Fig5.xls". It is possible to incremental fossil fuel consumption in the world and China by sector from 2000 to 2020.(Source: Komiyama, R., Li, Z. and Ito, K. (2005) `World energy outlook in	Rejected. Shortage of space and too much information on China in this text.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						2020 focusing on China's energy impacts on the world and Northeast Asia', Int. J. Global Energy Issues, Vol. 24, Nos. 3/4, pp.183-210.) (Ryoichi Komiyama, The Institute of Energy Economics, Japan (IEEJ))	
4-397	A	19	31	19	32	WEO2005 projected that oil demand will grow by 44% between 2003 and 2030 and gas demand will grow by three fourth. (Fatih Birol, International Energy Agency)	Accepted. We should say that oil demand will grow around 45% (WEO,2005 and IEA, 2005b).
4-398	A	19	37		38	will have' and 'must' too prescriptive wording? (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted. Replace by 'To avoid GHG release by transportation fuels it is necessary to rely on alternatives such as electric batteries, biofuels, hydrogen'
4-399	A	19	37	19	38	write "that capture and store CO2" (Marco Mazzotti, Institute of Process Engineering)	Accepted.
4-400	A	19	38	19	38	Change "sequester" to "store" here and in all the Report, to be consistent with the IPCC SRCCS (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted
4-401	A	19	41	19	47	Again the references to fossil energy resources (unspecified) remaining abundant, total resources available for … oil … should last for decades are likely to give a misleading impression. (Michael Jefferson, World Renewable Energy Network/Congresses)	Accepted. Change resources in reserves.. Move the paragraph up to line 32. Only refers to coal since oil and gas were previously discussed. Information about Fig 4.3.1 must be presented when discussing oil and gas and repeated for coal.
4-402	A	19	41	19	50	This part of the chapter avoids addressing the issue of oil depletion, maybe a mention and a reference to par.4.3.1.1 would fit here. (Antoine BONDUELLE, E&E_Consultant)	Accepted but use the reference in Oil Section.
4-403	A	19	42	19	45	Delete paragraph, because this informatino has been given several times already. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted.
4-404	A	19	42			Fossil energy resources do not remain abundant. Coal resources remain abundant, not oil or even natural gas. (Stan Bull, National Renewable Energy Laboratory)	Agree. Remove sentence.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-405	A	19	47			Again, too optimistic. Tone it down to agree with the published data. (Stan Bull, National Renewable Energy Laboratory)	Agree. Sentence redrafted.
4-406	A	20	1			Figure 4.3.1. This figure is not understandable? (Matti Melanen, Finnish Environment Institute)	Agree. It will be improved.
4-407	A	20	1	20	2	Fig. 4.3.1: I did not understand this figure. What is the unit of the vertical axis? Years? But then, the numbers are too small. Also I did not understand the scale in the legend. What is the unit? EJ/yr? But this does not match with the columns. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Agree. It will be improved.
4-408	A	20	3			Figure 4.3.1: This figure is not clear at all and must be revised. Make a clearer inset, clarify what the white area in the uranium column is. What are the numbers below the columns? (Marco Mazzotti, Institute of Process Engineering)	Agree. It will be improved.
4-409	A	20	6	22	35	The section on coal makes no mention of coal-to-synfuels (e.g. Fischer-Tropsch fuels) technologies such as that employed commercially on a large scale by Sasol in South Africa. See http://www.sasol.co.za/ for information on Sasol and its technologies. (Lee Lynd, Dartmouth College)	Accepted. Discuss this issue on P 22, after line 21, since Cogeneration will be discussed altogether in another site.
4-410	A	20	6			Section 4.3.1.1.1. - This section should add a mention of the option and potential for cofiring coal and biomass and cross-reference to page 41. (Stan Bull, National Renewable Energy Laboratory)	Accepted. But it will be discussed on biomass.
4-411	A	20	12	20	12	finish the sentence as "…minerals, chlorine, mercury and other impurities. On combustion, they are released...". At the end of the paragraph, a mention to the availability of technologies to clean up these contaminents could be given. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Sentence was deleted.
4-412	A	20	24	20	26	Why the asuumption of 4%?. Delete sentence or just give lasting years of reserves at "present rate of consumption" (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Sentence deleted.
4-413	A	20	25	27	41	General comment: It would be helpful if reserves (proven), and resources would be	Text has changed and we are only discussing

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						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)	reserves.
4-414	A	20	32			www.peatmoss.com this type of WWW references should also be in References list (incl. Date). (may occur more than once, not mentioned repeatedly) (Ad Seebregts, Energy research Centre of the Netherlands)	Thanks.
4-415	A	20	33	20	34	This sentence and its accompanying reference is not necessary here. Sulfur control is a very big issue for coal-based technologies (with hundreds of peer reviewed referneces) and is not right to bring it here with a single reference to a grey literature paper. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted. Sentence deleted.
4-416	A	20	36			There are alternatives to coal - singificant improvements in energy efficiency combined with integrate renewable energy systems. You are in effect saying that the only possible future is a coal future! (Danny Harvey, University of Toronto)	Accepted. Change sentence on lines 36 and 37 to say 'The implementation of modern high-efficiency and clean utilization of coal tevhnologiesis is an important way to minimize adverse effects on society and environment'
4-417	A	20	42			as above (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted as above.
4-418	A	20	42	20	42	Carbon dioxide capture and storage ... (Marco Mazzotti, Institute of Process Engineering)	Accepted. Change to carbon dioxide capture and storage
4-419	A	20	45	20	48	Please quantify. Give a % increase in energy requirements or a % loss in energy efficiency, what are the energy losses when establishing Sox and Nox control technologies. For CO2 these are high, but are they relevant for these minor impurities? . (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Noted. The text was deleted.
4-420	A	20	45	45	49	DJ De-NOx and de-SOx causes higher generation cost and efficiency losses. But also mention the benefits of reduced acid rain etc. The efficiency losses are however compensated by efficiency improvement in power generation us such.	Noted. The text was deleted.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Ad Seebregts, Energy research Centre of the Netherlands)	
4-421	A	20	45	45	49	De-NOx and de-SOx causes higher generation cost and efficiency losses. But also mention the benefits of reduced acid rain etc. The efficiency losses are however compensated by efficiency improvement in power generation us such. (Daniel Jansen, Energy research Institute of the Netherlands)	Noted. The text was deleted.
4-422	A	20	45			The reference to 'clean coal' and 'virtually eliminated' should be deleted unless it can be scientifically referenced. 'Clean coal' is industry greenwashing and 'virtually eliminated' means that there are still pollutants being produced. (Kirsten Macey, Climate Action Network Europe)	Noted. The text was deleted.
4-423	A	21	16	21	41	I am worried about these 3 paragraphs from "Coal preparation and washing…" to "... up to 10%". What was the author´s motivation to choose these projects?. Space is a valuable thing in an IPCC report, and this is badly used here. Half a page is given to rather exotic technologies to clean coal before it is burned or gasified . Almost the same space is dedicated to describe the whole range power generation systems ¡ . If only half a page is dedicated to provide an overview of clean coal technologies for power generation (and the vast amount of literature and reports available on the subject), no even a word should be dedicated to production of "UCC" or futuristic ways of coal transport. Delete these paragraphs on coal cleaning projects, or expand the next section to cover hundreds of other projects all over the world aimed at making coal "clean". (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Noted. The text was deleted.
4-424	A	21	35	21	40	COMMENT: UCC(Ultra Clean Coal) which is developed by CSIRO, Australia is described in this draft paper. Now NEDO, Japan is also developing similar technology, "Hyper-Coal" technology. The technological target of Hyper-Coal is establishment of non-ash (ash content <200ppm) coal production. The remaining ash content level of Hyper-Coal process is lower than that of UCC (0.25%). The Hyper-Coal also aims accomplishment of high efficiency gas turbine generation. In the Hyper-Coal process, alkali metals that wear down turbine mechanism are removed off to negligible level. On the other hand, UCC process itself cannot remove such alkali metals enough. So, it means that UCC must need	Accepted. Add this extra reference.

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						another alkali removal process. We suggest that the Hyper-Coal is also should be described in this paper together with UCC. REFERENCES: Energy & Fuels 2004, 18, 995-1000, Energy & Fuels 2004, 18, 97-101; Fuel 84 (2005) 1487-1493; Fuel Processing Technology 86 (2004) 61-72; Fuel Peocessing Technology 85 (2004) 947-967; Coal Preparation, 25: 295-311, 2005 (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	
4-425	A	21	35	21	40	UCC(Ultra Clean Coal) which is developed by CSIRO, Australia is described in this draft paper. Now NEDO, Japan is also developing similar technology, "Hyper-Coal" technology. The technological target of Hyper-Coal is establishment of non-ash (ash content <200ppm) coal production. The remaining ash content level of Hyper-Coal process is lower than that of UCC (0.25%). The Hyper-Coal also aims accomplishment of high efficiency gas turbine generation. In the Hyper-Coal process, alkali metals that wear down turbine mechanism are removed off to negligible level. On the other hand, UCC process itself cannot remove such alkali metals enough. So, it means that UCC must need another alkali removal process. We suggest that the Hyper-Coal is also should be described in this paper together with UCC. REFERENCES: Energy & Fuels 2004, 18, 995-1000, Energy & Fuels 2004, 18, 97-101; Fuel 84 (2005) 1487-1493; Fuel Processing Technology 86 (2004) 61-72; Fuel Peocessing Technology 85 (2004) 947-967; Coal Preparation, 25: 295-311, 2005 (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted. Add the reference.
4-426	A	21	36			Section 4.3.1.1.2 - This section should add a mention of landfill gas, biogas, and other distributed production methods of methane-type fuels. These are very important for developing countries. As above, add a cross-reference to p. 41. (Stan Bull, National Renewable Energy Laboratory)	Refers to P 22 and not 21. Accepted. Should be included in Renewables.
4-427	A	21	39	21	40	puzzling inconsistency here (24% vs 10%)	.Accepted. Check CSIRO, 2005 to check

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						(Danny Harvey, University of Toronto)	GHG emission reduction as 24 or 10%..
4-428	A	21	43	22	34	This half a page aims at a summary of many very big issues in the generation of power and heat from coal. I do not think this has been writen by an expert with enough broad knowledge to decide what deserve mentioning in such a half a page summary on clean coal technologies . Please use as a CA somebody from the IEA clean coal center, or the IEA GHG R&D programe or somebody else. Also consider increeasing the lenght of this critical section to give a real sense of what is real, well established technologies to generate electricity hydrogen and heat in todays world, inlcuding expected developments in terms of efficiency gains and emission reductions goals. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted. We will ask reviewer to address the text to be redrafted by an expert on coal electricity generation.
4-429	A	21	43	21	45	In Japan, TEPCO's Hitachi-naka No.1 and Hirono No.5 have achieved thermal efficiency of 45% (LHV) or 43% (HHV). (Shigeo Murayama, The Federation of Electric Power Companies)	Please, can you forward a publication on these results. We would like to include the example but need a text.
4-430	A	21	43	22	21	Possibilities provided by "state-of-the-art" coal power plants might be slightly enhanced (see data provided by NEA-OECD-IEA (2005); adding IEA-CIAB 2005 as a reference might be useful). Given the current situation (average efficiency of coal-fired generation: 36% in the OECD, 30% in developing countries), the draft suggests that with an appropriate policy, thermal efficiency of new plants in developing countries could reach 36% in the next decades. But "state-of-the-art" technologies which are currently put on line in OECD countries have a thermal efficiency above 40%. So it is fair to think that with appropriate policies that would favour the development of the same best technologies in China, India and other developing countries as the ones developed in OECD countries, the world future average efficiency of coal plants (with a significant impact of CO2 emissions) could be enhanced. The report could take into account this fact.	Accepted. Change sentence like' ..worldwide but over 40%'. Use these references

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						References : IEA-CIAB 2005, "Reducing Greenhouse Gas Emissions: The Potential of Coal". IEA, Coal Industry Advisory Board. Available for free on IEA website (www.iea.org). NEA-OECD-IEA (2005), « Projected costs of generating electricity » 2005 update. Document already referenced by IPCC 1st draft. (Jean-Yves CANEILL, Electricité de France)	
4-431	A	21	44		45	36% as 'max' seems too low. E.g. in the Netherlands an average and operational efficiency of about 42% has been feasible for coal-fired plants in 1994/1995 (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted. Change sentence like' ..worldwide but over 40%'. Use these references
4-432	A	21	44			To eliminate technical uncertainties, the first efficiency mention should say that it is on the basis, presumably, of lower heating value. (Catherine Beard, Greenhouse Policy Coalition (NGO representing energy intensive sector))	Accepted. Change sentence like' ..worldwide but over 40%'. Use these references
4-433	A	21	44			An efficiency for 'advanced' coal-fired power plants of 36% is quoted. Many countries have average better than this (Graus and Voogt, Updated comparison of power efficiency at grid level, Ecofys, 2005). Denmark has plants up and running at 46% efficiency. This cannot be obtained everywhere, but plants with 36% conversion efficiency can be considered obsolete for decades already. (Blok Kornelis, Ecofys)	Accepted. Change sentence like' ..worldwide but over 40%'. Use these references
4-434	A	21	45	21	47	The statement of "An improvement in efficiency of 1% reduces the CO2 emission /MWh by about 2.5%" is not correct. Because the efficiency = energy generated / energy of coal consumed in generation, total CO2 emission is in inverse proportion to the efficiency. As a result, the derivative of CO2 emission to the efficiency, d(CO2)/d(eff), is not a constant. On the contrary, d(CO2)/d(eff) = - M / square(eff), where, M is a positive number. Thus, the lower the efficiency, the higher the deriative. (Yong Zhao, China Huaneng Technical and Economic Research Institute)	Rejected. At 40% efficiency every 1% improvement in efficiency reduces emission by 2.5%. We are near this value for practical applications thus no need to make it complex.

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4-466	A	22	0			Cogeneration needs expansion to explain how cogeneration (or CHP) provides appreciably greater end use energy service than independent (separate generation of power and heat), thereby reducing net global carbon emissions. (Steven Freedman, Energy Consultant)	Accepted. The text will be revised.
4-435	A	22	1	22	6	"Akimoto, K., T. Tomoda and Y. Fujii, Development of a mixed integer programming model for technology development strategy and its application to IGCC technologies, Energy, 30(7), pp. 1176-1191, 2005" presents the perspectives of the installation of IGCC. I recommend referring the literature in this section. (Keigo Akimoto, Resaerch Institute of Innovative Technology for the Earth (RITE))	Thanks. We will search the quoted reference and try to list it.
4-436	A	22	3			COMMENT: Since IGCC is mentioned, IGFC(Integrated Coal Gasification Fuel Cell Combined Cycle) should also be indicated as followsl: "IGFC systems, which combine IGCC with fuel cell, are called "triple combined cycle" and are expected to lead to even higher efficiencies (>60% of efficiency at generating end) REFERENCES: 'Operational Experiencee at 150t/d EAGLE Gasification Pilot Plant' Gasification Technologies 2003; Journal of the Japan Institute of Energy, 82, 836-840 (2003) (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted. Refernce added to line 17.
4-437	A	22	3			Since IGCC is mentioned, IGFC(Integrated Coal Gasification Fuel Cell Combined Cycle) should also be indicated as followsl: "IGFC systems, which combine IGCC with fuel cell, are called "triple combined cycle" and are expected to lead to even higher efficiencies (>60% of efficiency at generating end) REFERENCES: 'Operational Experiencee at 150t/d EAGLE Gasification Pilot Plant' Gasification Technologies 2003; Journal of the Japan Institute of Energy, 82, 836-840 (2003) (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted. Refernce added to line 17.
4-438	A	22	6	22	6	capture and separation of CO2'. 'Capture' and 'separation' are essentially the same thing. Should it be 'capture and storage'? (Kenneth Möllersten, Swedish Energy Agency)	Accepted. Change to Capture and Storage..
4-439	A	22	6	22		replace the word "separation" with storage	Accepted. Change to Capture and Storage

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						(Daniel Jansen, Energy research Institute of the Netherlands)	
4-440	A	22	6	22		DJ replace the word "separation" with storage (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted. Change to Capture and Storage
4-441	A	22	8	22	21	Please make sure that figure 4.3.2 is not conflicting with Figure 3.6 of the special report on CO2 capture and storage (Daniel Jansen, Energy research Institute of the Netherlands)	Check against the final version of SRCCS, fig 3.6
4-442	A	22	8	22	21	DJ Please make sure that figure 4.3.2 is not conflicting with Figure 3.6 of the special report on CO2 capture and storage (Ad Seebregts, Energy research Centre of the Netherlands)	Check against the final version of SRCCS, fig 3.6
4-443	A	22	9	22	10	Actually, the improvement in efficiency of this supercritical plant benefits partly from cold sea water cooling. Beyond supercritical generation, technological improvements have been made worldwide with steam temperature higher than 600ºC and pressure around 25 - 31 MPa, called ultra supercritical. (Yong Zhao, China Huaneng Technical and Economic Research Institute)	Please, provide reference to include your comment.
4-444	A	22	10			COMMENT: It should be noted whether "efficiency of 48.5%" is based on LHV standard or HHV standard. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted. Look IPCC, 2001 to search for HHV or LHV?
4-445	A	22	10			It should be noted whether "efficiency of 48.5%" is based on LHV standard or HHV standard. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted. Look IPCC, 2001 to search for HHV or LHV?
4-446	A	22	11			96% desulphurisation seems quite high. Doubts on realism of this assumption (Ad Seebregts, Energy research Centre of the Netherlands)	The text was deleted.
4-447	A	22	14			are 2015 and 2025 efficiencies mentioned in Ref's (IPCC, 2001) or (DEA, 2004)? If not, provide references. Additional Reference: Lako, P., 2004, Coal-fired power technologies: Coal-fired power options on the brink of climate policies, ECN report ECN-C--04-076, October 2004, Petten, The Netherlands. (Ad Seebregts, Energy research Centre of the Netherlands)	Line 13 and 14 deleted.
4-448	A	22	16	22	21	This para seems to describe a FC with a GT/CC as bottoming cycle. Although a high level of efficiency (63%) could be achieved using this technology, there is	Accepted. We removed the word ‘zero emissions’.

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						nothing in this para that explains how "zero emissions" could be possible. (Kenneth Möllersten, Swedish Energy Agency)	
4-449	A	22	16		22	Fossil Fuels p22 line16-22 The paper provides a good overview about the status of fossil fuel Technologies but the overall description of new coal technology is over optimistic e.g page 22, line 20ff: they quote DOE´s view that coal-gas turbines could reach an efficiency of 63% by 2010. In the real world companies like RWE failed to deliver there high promises around efficient coal power plants., They abandoned the so called Kobra project (a lignite power plant with over 50% efficiency almost 10 years ago. Coal gasification processes experience substantially problems in the past. I wouldn´t share the hope to be more sucessfull within the next 4 years. (Arjette Stevens, De Koepel)	Accepted. We changed line 21 to read as 'DOE optimistically estimates..'.
4-450	A	22	21			If the DOE 63% claim is seen as unrealistic by some commentators, this should be stated so as not to create false expectations in such a short timeframe. (Catherine Beard, Greenhouse Policy Coalition (NGO representing energy intensive sector))	Accepted. We changed line 21 to read as 'DOE optimistically estimates..'.
4-451	A	22	23	22	33	COMMENT: We suggest to add (1)distributed use of energy, (2) electric-load leveling effects and (3) reliable energy supply, as advantages of cogeneration. More specifically, we sugest the text below: (1)"Cogeneration systems promote distributed energy use. Power or thermal loss through transmission and storage is signficant. But cogeneration systems allow users locating far from a large power station to efficiently gain electricity and heat where they are. (2) It contributes to electric-load leveling by operating such systems in the peak period of power demand, for example, in the hot summer season and daytime. (3)It strenthens reliability of energy supply through utilizing such systems in conjunction with commercial power generation and as an additional heating	Noted. Section moved to 4.4.1.1.3.

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						facility. Furthermore, it can also be used in an emergency such as in natural disasters. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	
4-452	A	22	23	22	34	COMMENT: Cogeneration is described in this paragraph with a subheading which is under 4.3.1.1.1 Coal and peat. However, the item is related to heavy oil and natural gas as well as (gasified) coal and it is better to put in 4.3.1.1 Fossil Energy that is above 4.3.1.1.1. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Noted. Section moved to 4.4.1.1.3.
4-453	A	22	23	22	33	We suggest to add (1)distributed use of energy, (2) electric-load leveling effects and (3) reliable energy supply, as advantages of cogeneration. More specifically, we sugest the text below: (1)"Cogeneration systems promote distributed energy use. Power or thermal loss through transmission and storage is signficant. But cogeneration systems allow users locating far from a large power station to efficiently gain electricity and heat where they are. (2) It contributes to electric-load leveling by operating such systems in the peak period of power demand, for example, in the hot summer season and daytime. (3)It strenthens reliability of energy supply through utilizing such systems in conjunction with commercial power generation and as an additional heating facility. Furthermore, it can also be used in an emergency such as in natural disasters. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Noted. Section moved to 4.4.1.1.3.
4-454	A	22	23	22	34	Cogeneration is described in this paragraph with a subheading which is under 4.3.1.1.1 Coal and peat. However, the item is related to heavy oil and natural gas as well as (gasified) coal and it is better to put in 4.3.1.1 Fossil Energy that is above 4.3.1.1.1. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Noted. Section moved to 4.4.1.1.3
4-455	A	22	26	22	27	A "well-designed and operated" cogeneration scheme dont' lead always to cost savings. Heat distribution can destroy the profitability if consumer density is low, no matter how good the cogeneration plant is. You may argue, that the plant is not	Rejected. Too much detail for lack of space.

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						"well-designed" in this case, but then the statement is a tautology. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	
4-456	A	22	27	22	27	Efficiency in the context of cogeneration is wrong -you cannot add heat and electricity due to their different exergy (no typo) values. Please use "fuel effectiveness or fuel utilization" (H-Holger Rogner, IAEA)	Accepted. Change line 27 to read: 'will provide better fuel utilization and lower CO2 emissions.
4-457	A	22	32			Remove reference to 'clean coal' for above reason (Kirsten Macey, Climate Action Network Europe)	Accepted. Check figure 4.3.2.
4-458	A	22	35	22	35	Mercury emissions from coal combustion are harmful. If authors consider convenient can add "Besides GHG, SO2 and Nox emissions, an estimated 2,000 tones of new mercury is released to the environment annually, mainly from coal-fired power stations (1470 tones)." (Global Mercury Assessment. UNEP Geneva, December 2002). (Jorge Gasca, Mexican Petroleum Institute)	Rejected. We are reserving words for Climate Change issues.
4-459	A	22	35	22	35	This section on gas and petroleum resources in an IPCC report should mention perhaps the most intersting data, namely the amount of carbon in the different resources. This has profound implications and omission of htis is potentially a major oversight. Some data and implications are discussed briefly in IPCC TAR, PSM, and this chapter should build upon this, for additional discussion see eg Grubb, M. (2001). "Who's afraid of atmospheric stabilisation? Making the link between energy resources and climate change." Energy Policy 29(11): 837-845. (Michael Grubb, Cambridge University)	Accepted, but it is already mentioned in 4.1.2.
4-460	A	22	36	25	20	As with coal , the section on methane fuels makes no mention of coal-to-synfuels technologies. (Lee Lynd, Dartmouth College)	Accepted. Discuss this issue on P 22, after line 21, since Cogeneration will be discussed altogether in another site.
4-461	A	22	36			Section 4.3.1.1.2 - On gas, the draft might emphasize that the context has dramatically changed over the last few years. In the 90s, the development of CCGTs was prevalent in industrialized countries. The technology was cheaper than	Rejected. Up to these NG prices CCGTs will continue to be used since the operational cost is transferred to the consumer. We need much

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						coal or nuclear technologies, in a context of abundant gas infrastructures and low gas prices (2-3 US $/Mbtu). SRES scenarios reflected this context as gas power was widely considered as a major strategy to reduce CO2 emissions at a low cost, (gas plants cheaper than coal plants). But today the prospects are quite different. In the World Energy Outlook 2005, IEA assumes that natural gas prices will be (in US $2004/Mbtu) 5.9 in 2020 and 6.2 in 2030 for US imports (5.2 and 5.6 for European imports), much higher than in the WEO 2002 (in $2000/Mbtu: 3.3-3.4 in 2020 and 3.8-4.0 in 2030 for US and European imports). Thus gas technology, which is not CO2 free, has become a costly strategy, both in terms of security of supply and climate change. (Jean-Yves CANEILL, Electricité de France)	higher NG costs to pevent further installation og CCGT.
4-462	A	22	38	25	19	Some points regarding advantages of natural should be added as follows: (1)Important fuel for distributed generation: Utilizing natural gas can promote diffusion of distributed generation systems as it is an important fuel for such systems as cogeneration systems including fuel cell.Natural gas is supplied to a broad range of users through pipeline networks. (2) Convertible to automotive fuel: Natural gas is methane-based and is convertible to alternative automotive fuels such as GTL, DME and methanol. (3) Promising supply source of hydrogen: For a low carbon economy, stationary fuel cells and fuel cell vechicles are promising technologies. The fuel of fuel cells is hydrogen and its production technology of reforming natural gas has been established. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Noted.
4-463	A	22	38	25	19	Some points regarding advantages of natural should be added as follows: (1)Important fuel for distributed generation: Utilizing natural gas can promote diffusion of distributed generation systems as it is an important fuel for such systems as cogeneration systems including fuel cell.Natural gas is supplied to a	Noted.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						broad range of users through pipeline networks. (2) Convertible to automotive fuel: Natural gas is methane-based and is convertible to alternative automotive fuels such as GTL, DME and methanol. (3) Promising supply source of hydrogen: For a low carbon economy, stationary fuel cells and fuel cell vechicles are promising technologies. The fuel of fuel cells is hydrogen and its production technology of reforming natural gas has been established. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	
4-464	A	22	38	25		Section 4,3,1,1,2, Comment: Liquefied Petroleum Gases Liquefied Petroleum Gases (LPG) is a by-product of natural gas processing and crude oil refining. Total global production of LPG amounted to over 217 million tonnes in 2004 (MCH/WLPGA 205). With an annual demand of over 250 million tonnes of oil equivalent, LPG consumption is equivalent to 10% of global natural gas consumption (Venn 2005). Before natural gas can be transported or used, the Liquefied Petroleum Gases (which are slightly heavier than methane, the major component of natural gas) are separated out. The chemical composition of LPG may vary, but it is predominantly made up of butane and propane. Depending on the "wetness" of a producing gas field, gas liquids generally contain 1%-3% of the unprocessed gas stream. Worldwide, gas processing is a source of approximately 60% of LPG produced. LPG production from these sources is a natural derivative. That means production of LPG is assured since the primary motive for gas processors and refiners is to produce fuels other than LPG. Although tied to the production of natural gas and crude oil, LPG has its own distinct advantages. LPG has a high-energy content on a per-tonne basis (in its liquid state) compared to traditional fuels and other oil products, which makes it easy and efficient to transport and use (Venn 2005). These characteristics have made LPG a popular fuel for cooking and heating, for industrial processes and as an	Accepted. Add a sentence about LPG quote the amounr and C emission from burning.

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						alternative automotive fuel. In 2004, half of LPG consumption was in the domestic sector. Global consumption of LPG as a domestic fuel is expected to double between 1990 and 2010. Source John Venn "Rapid Access to Modern Energy Sevices Using LP Gas" Energy & Environment. Volume 16 No. 5 Multi-Science publishing Co.ltd Brentwood 2005 The data for 2004 has been updated from Statistical Review of Global LP Gas 2005 MCH Oil & Gas Consultancy/World LP Gas Association. 2005. (Johanna Wickstrom, World LP Gas Association)	
4-465	A	22	40	22	40	Please cross check with Table 4.3.1. The number for conventional natural gas of 10,000 EJ is different from that found in the table. Overall, there needs to be a scrubbing of the data sets, in the numbers presented, that come from BP and WEC. (Arthur Lee, Chevron Corporation)	Accepted. Check either 10,000 or 12,000 EJ.
4-477	A	23	0	23		Figure 4.3.11. The statement that "Renewable energy technologies are intermittent over various time frames and need to be managed accordingly if to provide reliable energy supply" needs to be put in context with conventional resources. No power plant or resource is 100% reliable. Large coal, nuclear, and gas plants often go offline for unexpected reasons and pose a much bigger risk to disrupting the entire electricity grid than smaller, modular renewable energy technologies. Some renewable technologies like biomass, landfill gas and geothermal operate as "baseload" plants just like coal and nuclear plants. In addition to fossil fuels being limited over time, they are also subject to short-term constraints. For example, coal has been constrained in the US at times due to constraints on the rail system. Oil and natural gas supplies were significantly disrupted in the US during the huricane season last year and are constrained during the winter heating heating season in some parts of the county. While wind and solar are variable output resources, their output is fairly predictable over certain periods of time and has greatly improved with advances in forecasting. (Steve Clemmer, Union of Concerned Scientists)	Accepted The grid stability requirement needs related to large power plants derived to be mentioned. Wrong page number. Should be P 36. Renewable Group should analyse.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-467	A	23	1			USGS, 2005 missing in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Thanks.
4-468	A	23	1			USGS, 2005 missing in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Thanks.
4-469	A	23	4			The phrasing used suggests that nitrogen oxides are particulates. While not my field of expertise, I had only known these to be precursors to particulates, but that they themselves remained gaseous (thus not particulate). (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Accepted. Take out except and replace with releases
4-470	A	23	8	23	8	Use of gas is produces… Delete "is" (H-Holger Rogner, IAEA)	Accepted. Typo error.
4-471	A	23	11	23	11	Should mention landfill gas and then refer to chapter 10 (Casey Delhotal, USEPA)	Partially accepted. We will add a section on biogas in this Chapter. Neverthelesss, avoid overlap with Chapter 10.
4-472	A	23	15	23	46	COMMENT: It should also be noted that methane hydrate exists relatively evenly in the world. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted. We will say that it is poorly known .
4-473	A	23	15	23	46	It should also be noted that methane hydrate exists relatively evenly in the world. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	See above.
4-474	A	23	24	23	24	The 8000 EJ resource cited is speculative, as describe here in the text. However, the Table 4.3.2 has no caveat, stating this speculative nature. I recommend adding a footnote to the Table 4.3.2. (Arthur Lee, Chevron Corporation)	Accepted. We will add a note on that.
4-475	A	23	38	23	43	It should be noted that increasing temperatures due to climate change destabilise gas hydrates. Permafrost is melting in the Arctiv releasing large amounts of methane into the atmosphere. (Gabriela Von Goerne, Greenpeace)	Rejected. Not discussed in the energy chapter.
4-476	A	23	41	23	41	60 000 EJ vs. 800 000 EJ in Table 4.3.2? Explanation for the difference = different literature sources?	Accepted. Let us check if the range goes from 60,000 to 800,000 EJ.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Matti Melanen, Finnish Environment Institute)	
4-478	A	24	7	24	10	Refer to chapter 10 (Monique Hoogwijk, Ecofys)	Thanks. All paragraph deleted.
4-479	A	24	13	24	14	change "safety" to "safely". I disagree that LNG can be more safely transported than, say, nitrogen, helium or CO2 for CCS. (H-Holger Rogner, IAEA)	Sentence on line 13 deleted.
4-480	A	24	46	25	16	"Akimoto, K., A. Hayashi, T. Kosugi and T. Tomoda, Analysis of R&D Strategy for Advanced Combined Cycle Power Systems, Transactions of the Institute Electrical Engineers of Japan (IEEJ trans.), 126-C(1), 2006" (the manuscript is attached) presents the perspectives of the installation of CCGT technologies including the importance of the component technologies. I recommend referring the literature in this section. (Keigo Akimoto, Resaerch Institute of Innovative Technology for the Earth (RITE))	Rejected. Too much detail.
4-481	A	24	50			Simple cycle instead of single cycle (Daniel Jansen, Energy research Institute of the Netherlands)	
4-482	A	24	50			DJ Simple cycle instead of single cycle (Ad Seebregts, Energy research Centre of the Netherlands)	Rejected. The terminology is Single Cycle.
4-483	A	24	50			DJ Better to give a range of efficiencies 32 - 40% (See Gas turbine world Hand book) (Ad Seebregts, Energy research Centre of the Netherlands)	Rejected. The terminology is Single Cycle
4-484	A	24	50			Better to give a range of efficiencies 32 - 40% (See Gas turbine world Hand book) (Daniel Jansen, Energy research Institute of the Netherlands)	Accepted. We will use 32 to 40%.
4-485	A	25	1			DJ Better to give a range of efficiencies 50 - 56 (See Gas turbine world - Hand book) (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted. We will use 32 to 40%.
4-486	A	25	1			Better to give a range of efficiencies 50 - 56 (See Gas turbine world - Hand book) (Daniel Jansen, Energy research Institute of the Netherlands)	Accepted. We will use 50 to 56%.
4-487	A	25	6	25	16	The purpose of this section is not clear. What does the author wants to tell here.	Accepted. Explain better the issue and

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						This include also Figure 4.3.3 Why the comparison with a PAFC systems? What's the point the authors want to make? It is probaly better to include this section in paragragh 4.4.3 Heat (Daniel Jansen, Energy research Institute of the Netherlands)	consider economy of scale. Combined cycle can be a better option than cogeneration but it is cost effective for large size (above 30MW).
4-488	A	25	6	25	16	DJ The purpose of this section is not clear. What does the author wants to tell here. This include also Figure 4.3.3 Why the comparison with a PAFC systems? What's the point the authors want to make? It is probaly better to include this section in paragragh 4.4.3 Heat (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted. Explain better the issue and consider economy of scale. Combined cycle can be a better option than cogeneration but it is cost effective for large size (above 30MW). Remember that quite often heat is neede for other purpose than cooling.
4-489	A	25	6	25	16	Here's discription is very appropriate. Heat-pump technology is a crucial element for the heating, ventilation & air-conditioning or HVAC, refrigeration, and now water heating. Therefore advanced heat pump technology would be an especially effective measure to address climate change in developing countries, where the demand for air conditioning is expected to grow rapidly in association with economic growth and improved living standards. Compared to conventional freon refrigerant, CO2 refrigerant heat pumps have superior heating properties, so work is being done to extend their usage to hot water heaters. In addition, compared to freon refrigerant, CO2 refrigerant's impact on global warming is extremely small, meaning that heat pumps that use this coolant are environmentally friendly. One research reports that a complete shift from conventional systems to the advanced heat pumps for space heating, cooling and hot water supply, would potentially reduce 98 million tons of CO2 in Japan(Heat Pump & Thermal Storage Technology Center of Japan). (Shinichi Nakakuki, Tokyo Electric Power Company)	Noted. No action.
4-490	A	25	8	25	14	These statements, and the Fig 4.3.3 are very confusing. The numbers in Fig. 4.3.3 do not even add up. (Arthur Lee, Chevron Corporation)	Accepted. Explain better the issue and consider economy of scale. Combined cycle can be a better option than cogeneration but it

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
							is cost effective for large size (above 30MW
4-491	A	25	10	25	10	What or who absorbed the heat pump? absorbtion heat pump? (Kenneth Möllersten, Swedish Energy Agency)	Accepted. Explain better the issue and consider economy of scale. Combined cycle can be a better option than cogeneration but it is cost effective for large size (above 30MW
4-492		25	10	25	16	This simulation is only one example among many. There are various systems that ratio of the electricity and the heat is different or the heat is directly used as steam or hot water. It is incorrect to conclude by only one simulation. I request to authors to delete these sentences or add some other examples including the comparison of system efficiency between cogeneration and conventional system. ()	Accepted. In the text consider also the situation where heat is needed and not only cooling.
4-493		25	10	25	16	There are no references in this text. ()	Thanks. Add references.
4-494		25	10	25	16	The demand side technology should not be treated in this chapter 5. The technology of residential and commercial buildings should be treated in chapter 6 and that of industrial is in chapter 7. ()	This is correct but just a brief comment is added. Cogeneration will be discussed as a block and text will be reduced.
4-495	A	25	10	25	16	I suggest that object of comparison to advanced CCGT should be changed from PAFC to conventional generation technologies such as oil-fired or conventional gas-fired. This comparison would be assumed under the condition where these technologies are used in commercial buildings which normally have demand for both heating and cooling. It is not practical that only cooling for air conditioning has been considered in this case. In addition, total efficiency of CHP systems, in which energy losses can be used for various types of heat demand such as process steam, hot water supplying, heating, and air conditiong (as well as CO2 reduction potential of those systems), should be evaluated taking into account various kinds of heat demand totally. In this point, this comparison is not appropriate due to partiality. (Michinobu Furukawa, International Institute for Applied Systems Analysis)	Accepted. Explain better the issue and consider economy of scale. Combined cycle can be a better option than cogeneration but it is cost effective for large size (above 30MW). Remember that quite often heat is neede for other purpose than cooling.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-496	A	25	11	25	11	See earlier comment on "efficiency of cogeneraion system" Use fuel effectiveness (H-Holger Rogner, IAEA)	Accepted. Let us exchange 'efficiency' by 'carbon emission'.
4-497	A	25	23	27	5	The concept of oil depletion and uncertainty on the peaking of oil production is well ascertained, although there is a gap in the representation between p25 l.36-44 ("peaking is happening") and p25 l46 and beyond ("oil reserves will last long"). One suggestion is to admit at that stage the controversy between a dominant view et a challenging position. One interesting reference to illustrate this controversy could be Legget J. 2005 "The empty tank", Random House N.Y. USA where the author, an avowed believer in early peaking of oil, describes the danger coming more of a runaway climate change due to a race to coal than the decline of conventional petroleum by itself. (Antoine BONDUELLE, E&E Consultant)	Accepted. Add this reference to P 26, line 45.
4-498	A	25	24		28	Like previous subsections, start with numbers on EJ (or Gtoe) oil reserves (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted. Delete paragraph from line 24 to 28 and Fig 4.3.4. Start Conventional oil with amount of reserves, bringing lines 46 to 50 to line 33. Use always EJ units.
4-499	A	25	24		28	Like previous subsections, start with numbers on EJ (or Gtoe) oil reserves (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted. Delete paragraph from line 24 to 28 and Fig 4.3.4. Start Conventional oil with amount of reserves, bringing lines 46 to 50 to line 33. Use always EJ units
4-500	A	25	34	25	34	"non solar"?? Would the 40% figure change if we included solar energy consumption?. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted. Quote oil share as a fraction of total primary energy being used.
4-501	A	25	35	25	35	Oil is produced in far more than 42 countries. A dimension of about 100 is realistic. (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Accepted. Change to 'It is produced by more than 50 countries….'
4-502	A	25	36	25	38	Either explain and justify what is meant by "game playing" by industry or delete the phrase. Left as is it is an unjustified slur. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted. Change sentence to 'lack of reliable data and the well understood confidentialyty of information of oil industry.
4-503	A	25	37	25	37	"Game playing" is an accusation not backed up by any evidence. IPCC should	Accepted. Change sentence to 'lack of reliable

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						remain true to its role of assessing policy-relevant facts, not making accusations with no basis in fact. (Arthur Lee, Chevron Corporation)	data and the well understood confidentialyty of information of oil industry
4-504	A	25	37	25	39	""game playing" by the industry" - inappropriate cheap shot. A "lack of reliable data" is a sufficient reason to cite. Line 39, reference to "problems for modern industrial society" is unclear - problems because of the uncertainty, or problems if the peak is imminent? (Stan Bull, National Renewable Energy Laboratory)	Both comments accepted. Change sentence to 'lack of reliable data and the well understood confidentialyty of information of oil industry. Also delete sentence starting on line 38.
4-505	A	25	37	25	38	"game playing": I do not think this is appropriate and clear enough language for an IPCC report (Marco Mazzotti, Institute of Process Engineering)	Accepted. Change sentence to 'lack of reliable data and the well understood confidentialyty of information of oil industry
4-506	A	25	38	25	38	It is not just the industry (e.g. SHELL) but also many OPEC governments (H-Holger Rogner, IAEA)	Accepted. Change sentence to 'lack of reliable data and the well understood confidentialyty of information of oil industry
4-507	A	25	49	26	2	It should be noted that the USGS high estimate is the second highest ever proposed, has been subject to severe criticism, and is close to 50% higher than the cluster of mainstream views. (Michael Jefferson, World Renewable Energy Network/Congresses)	Noted. We would appreciate from the reviewer other reliable references that could be added to this paragraph.
4-508	A	26	2	26	3	724 Gbbl undiscovered oil probable: this data is not following statistical or rather explorational trends, but derives from a certain statistical calculation method, which is heavily criticised by large parts of the scientific community. Recommendation: skip this data. (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Noted. We are searching and requesting the reviewer for references covering the debate over these figures.
4-509	A	26	3		34	Check if lines 4 and 33 are consistent. Both refer to reserves lasting based on current rates of consumption (Ad Seebregts, Energy research Centre of the Netherlands)	Noted. Numbers are consistent.
4-510	A	26	3		34	Check if lines 4 and 33 are consistent. Both refer to reserves lasting based on current rates of consumption (Ad Seebregts, Energy research Centre of the Netherlands)	Noted. Numbers are consistent

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-511	A	26	11	26	11	Opec did not produce 51 million barrels per day, but around 30 million bpd (around 40% of world total). (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Accepted. Check figures using IEA and BP and OPEC web
4-512	A	26	12	26	14	the chain of causation "production peak of conventional oil makes price increase makes unconventional oil types more competitive" is over-simplified. Recommendation: skip this sentence. (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Accepted. Change sentence removing 'rate of extraction decline'
4-513	A	26	22			figure 4.3.5: If the figure were to be kept, some discussion and interpretation of it should be provided. (Marco Mazzotti, Institute of Process Engineering)	Accepted. Add further explanation about figure like a comment that in the last 20 years the estimated extractable oil resources are comparable.
4-514	A	26	29	26	34	There is a similar discussion at the beginning of the page!! (Marco Mazzotti, Institute of Process Engineering)	Accepted. Combine paragraph starting on P 25, line 46 with paragraph starting on P 26, line 25.
4-515	A	26	31	26	46	The statement that at current rate of use the reserves/resources will last for several decades has little meaning as the rate of use is commonly expected to rise substantially. The 'peak oil' point has already been made earlier. The 'peaking' issue related in the next paragraph is somewhat oversimplified - one could go into Hubbert etc. (Michael Jefferson, World Renewable Energy Network/Congresses)	OK, but it is already addressed in P 27, lines 1 to 4.
4-516	A	26	40		45	Reporting al these years of "oil peaking" is fine, but could an assessment be made of the value of the various reports (or e.g. the differences in approach, assumptions, etc.). (Blok Kornelis, Ecofys)	OK, but note this is discussed already in Fig 4.3.5.
4-517	A	27	17			Improvements of only 3 - 7%? Is this a per annum incremental range? (Michael Jefferson, World Renewable Energy Network/Congresses)	Accepted. Check Shell 2005 reference for finding the answer.Is a web site.
4-518	A	27	25	27	41	In its report: Alberta Reserves 2004 and Supply/Demand Outlook 2005, Section 2.1 (http://www.eub.gov.ab.ca/BBS/energystats/resources/default.htm ST98), the Alberta Energy and Utilities Board gives estimates of initial volume in place,	Accepted. We will check the reference and use it if reliable.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						ultimate potential recoverable bitumen and reserves of bitumen: initial volume in place of 279 billion M3 in Table 2.3, ultimate potential recoverable resources of 50 billion M3 on page 2-9, and reserves of 27.66 billion M3 in Table 2.1. Using a conversion factor of 41.8 GJ/M3, this gives initial volume in place of 11,286 EJ, ultimately recoverable resources of 2,090 EJ and reserves of 1,156 EJ. With bitumen being about 83% carbon by weight, and there being about 1 tonne of bitumen per M3, there are about .83 tonnes of carbon per M3. This gives corresponding carbon numbers of 232 Gt, 41.5 Gt, and 23 Gt. (Richard Hyndman, Canadian Association of Petroleum Producers)	
4-519	A	27	25	27	41	Some of the terminology should be changed to correspond to what is used to discuss Canada's bitumen resources. The "tar sands" in Canada have been referred to officially as oil sands for over 25 years. The resource is distinguished between "surface mineable" (rather than "open cast mining") and "in situ". (Richard Hyndman, Canadian Association of Petroleum Producers)	Accepted. Change tar sand to oil sand. Change open cast mine to surface mineable .
4-520	A	27	27	27	28	There are other options for treating heavy oil which are as promising as orimulsion. I suggest leaving the sentence out. (Torsten Clemens, OMV E&P)	Not clear comment. Nevertheless, change line 27 to read: 'One of the promising of these fuels is…'
4-521	A	27	40	27	41	Both tar sands and oil shales need large amounts of water and heat (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Accepted. Sentence will be redrafted to include detailed figures about energy required for oil sand and shale oil (Bill Moomaw).
4-522	A	27	40	27	41	Oil shales also require a large amounts of heat for extraction of oil. The word whereas suggests that tar requires heat but oil shales require water. In both cases heat is neaded. (Torsten Clemens, OMV E&P)	OK. The same as above.
4-523	A	27	44	30	29	A discussion of institutional issues and relation to the Kyoto Protocol is missing. The differences in knowledge level and risks between geological and ocean storage should be emphasized; i.e. more risk associated with ocean storage. (Asbjørn Torvanger, CICERO)	Noted.
4-524	A	27	44			The section should have a separate sub-section on cost figures (summarizing the	He risks are addressed in P 29 starting line 39.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						findings of the IPCC special report on CCS). (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	
4-525	A	27	44			Section 4.3.1.2 - Carbon capture & storage: as said by the draft, solutions don't seem out of reach but there is still considerable uncertainty on many aspects (costs, geology…). The draft might suggest that, under certain conditions (appropriate public policy, success of future "industrial prototypes" of "first-of-a-kind reactors", results of geological studies and experiments…), some industrial deployment of CCS might be expected in 2025 or 2030 in areas such as in the USA, and some years later in other parts of the world. (Jean-Yves CANEILL, Electricité de France)	Accepted. Cost will be addressed in 4.4 Mitigation Cost and Potential and Risks.
4-526	A	27	46			CCS was discussed in the Second Assessment Report (WGII, Chapter 16 from memory), with major input from Bob Williams. See also page 31, lines 4-17, in this FOD. (Michael Jefferson, World Renewable Energy Network/Congresses)	Noted
4-527	A	27	46	27	46	spelling - 'capture' should be captured. Perhaps 'followed by the transport and storage.' Need to define CCS? (Veronica Brieno Rankin, Michigan Technological University)	Accepted. Also change heading to Carbon dioxide capture and storage.
4-528	A	27	46	27	47	The term ‘appears to be feasible’ should be backed up by evidence first before this general statement is made. The IPCC Special report found that there were still a number of gaps in knowledge of CCS which need to be asssessed. (Kirsten Macey, Climate Action Network Europe)	Accepted. Change to “Carbon dioxide capture…….reservoirs may be feasible provided some gaps on knowledge are are bridged. (IPCC, 2005)’.
4-529	A	27	46	28	9	This paragraph should summarize the IPCC SRCCS, but actually does a bad job. I believe that a closer match with that report should be sought. For instance, biological sequestration in forests and soils should not be discussed or mentioned here where the focus is on capture from point sources and storage. Also the discussion about ocean, mineral carbonation and industrial uses should be refined	Partially accepted. Let us remove biological sequestration. But biomass power generation is a point source. Delete lines 6,7, 8, and 9.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						based on IPCC SRCCS. (Marco Mazzotti, Institute of Process Engineering)	
4-530	A	27	47	27	47	The technology of CO2 capture, transport and storage (CCS) will not directly mitigate global warming and by stating it this way, there will be room for much scientific debate. What it will do is reduce atmospheric anthropogenic emissions which in turn might assist in mitigating global warming. (Veronica Brieno Rankin, Michigan Technological University)	Accepted. Replace 'warming' by 'emissions' in line 48.
4-531	A	27	47	27	47	Add a sentence: "…appears to be feasible. Three industrial-scale geological storage projects are in operation and natural geologic accumulations of pure CO2 are encountered all over the world". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted. Start new sentence on 'Three industrial…'
4-532	A	27	47	27	47	CCS has not shown to be feasible so far. Much more R&D / time is needed. I would suggest to „could become feasible" in the future. (Gabriela Von Goerne, Greenpeace)	Accepted. Change to "Carbon dioxide capture…….reservoirs may be feasible provided some gaps on knowledge are are bridged. (IPCC, 2005)'
4-533	A	27	49	27	50	Should be '….it is found that….' (Veronica Brieno Rankin, Michigan Technological University)	Accepted.
4-534	A	28	1			Considering the uncertainty of the leakage level, you can't say CCS would allow for the continued use of fossil fuels. Efforts to reduce use of fossil fuels have to continue at any cases and fossil fuel era should come to the end in some point. Therefore, this sentence is misleading. (Kimiko Hirata, Kiko Network)	Accepted. Change 'would allow' by 'may allow' on P 28, line 1.
4-535	A	28	5	28	6	The use of 'subsurface geological formations' is more precise. The phrase 'the ocean' is too general. Under the ocean bottom must be differentiated from in the ocean water. This is particularly important, as a large portion of CCS activities will probably occur offshore. This, society needs to understand the difference. (Veronica Brieno Rankin, Michigan Technological University)	Accepted. Replace line 5 by 'Physical storage could take place in subsurface geological formation. (Fig 4.3.6).'
4-536	A	28	5	28	5	It is proposed to delete "the ocean and in mineral inorganic carbonates" because according to the IPCC Special Report on Carbon Capture and Storage these options	Accepted. See previous comment.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						are still in the research phase and the IPCC was not in a position to assign a quantitative figure to a hypothetical mitigation potential of ocean storage and storage in mineral inorganic carbonates and thus these options seem to be of a different quality and do not qualify to be mentioned. (Radunsky Klaus, Umweltbundesamt)	
4-537	A	28	5	28	9	Modify the paragraph, emphasizing that physical and chemical storage in geological formations has the greatest potential, that ocean storage is only at the research stage with many uncertainties, and that mineral carbonation is also mainly on the research stage. Don't talk about biological carbon sequestration there. (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted. Same as above.
4-538	A	28	6	28	7	This sentence seems to be a little out of context. I don´t understand how biological sequestration comes in here in relation to its potential (see chapter 9 and its discussion of the different estimates of potentials in LULUCF). " (Martina Jung, (Freelance))	Sentence was deleted.
4-539	A	28	6			DJ Delete " sentence along with… in forest and soils. Include some data with respect to the storage capacities See Special report on CCS (Ad Seebregts, Energy research Centre of the Netherlands)	Sentence was deleted.
4-540	A	28	6			Delete " sentence along with… in forest and soils. Include some data with respect to the storage capacities See Special report on CCS (Daniel Jansen, Energy research Institute of the Netherlands)	Sentence was deleted.
4-541	A	28	6	28	6	It is proposed to delete "and ocean storage" because according to the IPCC Special Report on Carbon Capture and Storage this option is still in the research phase and the IPCC was not in a position to assign a quantitative figure to a hypothetical mitigation potential of ocean storage and thus ocean storage seems to be of a different quality and does not qualify to be mentioned. (Radunsky Klaus, Umweltbundesamt)	Sentence was modified.
4-542	A	28	6	28	7	This broad statement should be supported by clear evidence - the link to a website advertising conference papers is not adequate. It is also not clear what the largest potential is for?	Sentence deleted.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Kirsten Macey, Climate Action Network Europe)	
4-543	A	28	7	25	8	The line "Using CO2 in industrial processes.. etc" needs re-formulation, looks like some words are missing (Daniel Jansen, Energy research Institute of the Netherlands)	Sentence deleted.
4-544	A	28	7	25	8	DJ The line "Using CO2 in industrial processes.. etc" needs re-formulation, looks like some words are missing (Ad Seebregts, Energy research Centre of the Netherlands)	Sentence deleted.
4-545	A	28	7	28	7	"ocean storage" is too general - please expain what is meant by this. (Veronica Brieno Rankin, Michigan Technological University)	Sentence deleted.
4-546	A	28	8	28	10	A more realistic sentence would be "Forming inorganic carbontaes has been porposed for some scientist but has not been demostrated in practice. Using CO2 in industrial processes does not capture CO2 becasue in most cases CO2 is reemited to the atmosphere after a short time " (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Sentence deleted.
4-547	A	28	13	28	32	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, 2005). (Gabriela Von Goerne, Greenpeace)	Rejected. We are not stating ocean should store CO2.
4-548	A	28	14	28	32	DJ Delete this entire section. Is not clear at all! What is purpose of this section. (Ad Seebregts, Energy research Centre of the Netherlands)	Rejected. The purpose is to explain that an open system can store CO2.
4-549	A	28	14	28	32	Delete this entire section. Is not clear at all! What is purpose of this section. (Daniel Jansen, Energy research Institute of the Netherlands)	Rejected. The purpose is to explain that an open system can store CO2.
4-550	A	28	21	28	21	Figure 4.3.7: Change the title (see above). Replace the reservoir "Chemical & Mineral Storage" by "Mineral carbonation" (to be consistent with the usual terminology and the previous figure 4.3.6). Replace the subscript cm by mc (CCSmc and Rmc). This figure is very interesting but the title should be improved.	Noted and modify.

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						(CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	
4-551	A	28	21	28	23	Change the title of figure 4.3.7 into a more explicit wording, fitting better the purpose of the figure. Could be "Global scheme showing fluxes of CO2 to various reservoirs by implementing CCS and biological carbon sequestration". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Noted and modify.
4-552	A	28	24	28	32	It is proposed to delete any reference to ocean storage. This is because long term models show that ultimately ocean storage finally results in the same atmospheric equilibrium concentration as if the emissions had been made to the atmosphere only. (Radunsky Klaus, Umweltbundesamt)	Rejected. See comment # 549.
4-553	A	28	29	28	32	There is no reference here to risks from ocean storage which is clearly outlined in the IPCC Special Report and should also be stated in this assessment report. (Kirsten Macey, Climate Action Network Europe)	Accepted. Add a sentence on risks.
4-554	A	28	35	32	13	Please make sure that this entire section is good and accura6te summary of the IPCC special report on CO2 capture and storage and please use the same wording as the IPCC report for maturity of the technology, economic potential, Storage potential, etc. In some parts of this section this is indeed the case in other parts it is not. (Daniel Jansen, Energy research Institute of the Netherlands)	Thanks. We will check.
4-555	A	28	35	32	13	DJ Please make sure that this entire section is good and accurate summary of the IPCC special report on CO2 capture and storage and please use the same wording as the IPCC report for maturity of the technology, economic potential, Storage potential, etc. In some parts of this section this is indeed the case in other parts it is not. (Ad Seebregts, Energy research Centre of the Netherlands)	Thanks. We will check.
4-556	A	28	35	32	13	DJ Please make sure that this entire section is good and accurate summary of the IPCC special report on CO2 capture and storage and please use the same wording as the IPCC report for maturity of the technology, economic potential, Storage potential, etc. In some parts of this section this is indeed the case in other parts it is	Thanks. We will check.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						not. (Ad Seebregts, Energy research Centre of the Netherlands)	
4-557	A	28	36	28	38	The statement that the cost of CCS is "high" should be revised since there is no context or scenario for comparing the cost of CCS to other options. Suggest breaking this sentence into two as follows to reflect what the Special Report actually says: "While large-scale power plants are the major source of CO2 emissions, there are at present no full-scale applications of CCS at such plants. Current estimates indicate that the cost of separation technology is highly variable, depending on the type and design of the power system, the method of storage, and the distance from plant to storage site." (Edward Rubin, Carnegie Mellon University)	Accepted.
4-558	A	28	43	28	45	Change to "…oxygen to produce separate streams of hydrogen used as an energy carrier and CO2 for storage". Alternatively you can expand a bit and say "…oxygen to produce and stream of mainly hydrogen and CO (syngas). This gas is forced to react with water to produce more hydrogen and CO2. The CO2 is then separated for storage and the hydrogen used to produce electricity or as an energy carrier " (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Noted. Sentence will be modified.
4-559	A	28	48	28	49	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)	Accepted. Change 'commercially proven' to 'ecomically feasible'.
4-560	A	28	49			Reference to Gonschorek et al seems unjustified. Does it say something different to the full IPCC SR (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Rejected.
4-561	A	29	1	29	7	Transport discussion -- the authors are commended for their careful reading of the IPCC SRCCS (Richard Doctor, Argonne National Laboratory)	Accepted..

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4-562	A	29	5			In the IPCC Special Report on CO2 CCS it states that experience with transportation of liquefied natural gas is currently done on a small-scale due to limited demand – which is left out of this section in the AR4 and should be included to understand the full assessment. (Kirsten Macey, Climate Action Network Europe)	Rejected. Experience with LNG is growing.
4-563	A	29	10	29	22	The whole para on storage must be re-written. It is very unbalanced with respect to geological storage options and mentions EOR in some detail but no other options. The statement that co2 resulting from combustion of oil would exceed the amount stored hangs in the air. Do the authors suggest that this circumstance will off-set the reduction by storage? The extra oil extracted will substitute other fuel alternatives that would have given rise to more or less emissions so that single statement calls for a deeper discussion. Another aspect that is not mentioned is that EOR will alter the supply curve for oil which might reduce the price of oil and thereby lead to larger consumption. (Kenneth Möllersten, Swedish Energy Agency)	Accepted. Line 16 will change to 'The Co2 resulting from burning the extra oil produced may, however, exceed the amount stored'
4-564	A	29	10			"Storage of CO2 in geological formations can be achieved…." While this may be technically true on some limited scale as has been the experience for tertiary oil recovery, this blatant and simple a sentence is misleading with respect to storing CO2 on the scale that would be needed for carbon emission reduction. Suggest "Storage of CO2 in geological formations is possible, at least on a limited scale, in oil fields..." (Stan Bull, National Renewable Energy Laboratory)	Rejected. See the large amount listed in SRCCS.
4-565	A	29	10	29	11	Replace saline formations by deep saline aquifers. And add an explanation about this storage option. Use for this the definition below (from "CO2 capture and geological storage", The BRGM series "Geosciences Issues", September 2005): "Aquifer: A permeable geological formation that contains water. The most superficial aquifers contain fresh water used for drinking supply. Aquifers at greater depth contain brine that is totally unsuited to human consumption. These are called deep saline aquifers. In places, aquifers contain oil and gas deposits when the pore water has locally been replaced by hydrocarbons. They may also contain	Accepted. Use deep saline acquifier.

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						deposits of pure CO2 of natural origin. This is the basis for the idea of storing CO2 in the pores of rocks, thus mimicking natural CO2 deposits." (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	
4-566	A	29	10	29	24	The use of words such as 'can' appears to be misleading. It has only been proven in a small number of situations for a small amount of time - therefore it is not clear how the authors can justify the statements "can be achieved" - particularly the reference to ocean storage. CCS has not been proven to safely store CO2 over a long-period of time, therefore language such as 'could' would be more appropriate. (Kirsten Macey, Climate Action Network Europe)	The sentence has been modified. See comment #563
4-567	A	29	14	29	22	Replace all the paragraph by the entire paragraph of the IPCC Special Report on CCS - Summary for policy makers p. 5 and 6 under point 7 (from "If CO2 is injected into suitable saline formations….up to Three industrial-scale storage projects….Others are planned".) (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted. We will adapt the material from SRCCs Sumary for Policy Makers for this text.
4-568	A	29	14	29	14	Add also a sentence saying that "CO2 storage in hydrocarbon reservoirs and unmineable coal seams can be combined with Enhanced Oil Recovery (EOR) or, potentially, Enhanced Coal Bed Methane recovery (ECBM), providing revenues from the oil and gas recovery. (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Rejected. This point is already described in the text.
4-569	A	29	15	29	16	I believe this comment is out of place and misleading; the question should rather be how much of the captured CO2 used for EOR actually stays in the reservoir. The issue is discussed in the IPCC SRCCS. (Marco Mazzotti, Institute of Process Engineering)	Accepted. We will modify based in poor quantification of stored CO2, as described in P 203, Chaper 5 of SRCCS.
4-570	A	29	20	29	31	In the results of the reference, it is described that the future power plant construction program should be considered when the CO2 reduction potential by the introduction of CGS is evaluated. When evaluating indirect CO2 recuction potential of the electricity final users conserved, it would be substantially important to consider which kinds of power plants in grid will be replaced by adopting measures of demand side including CGS systems, under any future power plant construction program. It's rather intelligible to be described as follows: These	Rejected. Not clear comment.

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						results suggest that the CO2 reduction potential by the introduction of CGS depends on the future power plant construction program, i.e. when evaluating indirect CO2 recuction potential of the electricity final users conserved, it's necessary to consider what kinds of power plants are scheduled to be built in the program and which power sources will be replaced by the installation of CGS as well. (Michinobu Furukawa, International Institute for Applied Systems Analysis)	
4-571	A	29	24	29	29	The current language and structure of this paragraph implies that ocean storage options are more developed than they really are. The section needs to be explicit that ocean storage may not prove to be a technically viable option in all cases. The discussion and conclusions reached in the SPM for the Special Report on Carbon dioxide Capture and Storage illustrate that geological and ocean storage should not be conflated and that there remains significant uncertainties in relation to the utility of ocean storage. (Spencer Edwards, Australian Greenhouse Office)	Noted. We will mention uncertainties on ocean storage.
4-572	A	29	27	29	28	and its ecological impacts' is missing from this statement which should then read: Ocean storage and its ecological impacts is still in the research phase. (Kirsten Macey, Climate Action Network Europe)	Accepted.
4-573	A	29	28	29	28	Something should be said about mineral carbonation to be consistent with IPCC SRCCS (Marco Mazzotti, Institute of Process Engineering)	Accepted and will change the name.
4-574	A	29	29	29	29	Insert a paragraph on mineral carbonation (3rd main storage option under CCS) (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted and will change the name
4-575	A	29	30			Section 4.3.1.2.1 - There should be a mention of the environmental seismic risks associated with an incredibly higher extent of CO2 storage in geological formations than we have ever had experience with. Leakage is not the only issue. (Stan Bull, National Renewable Energy Laboratory)	Accepted. We will add this risk on line 42.
4-576	A	29	30			The section should provide more info on the potential risks (even not yet fully understood) on ocean storage. In addition, necessary provisions for	Accepted. The same as comment # 4-571.

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						minimizing/eliminating these risks (both during the design phase as well as during the project implementation and operation) should be made more clear, so that the reader can compare this option to the other mitigation options. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	
4-577	A	29	34	29	34	The text reads, “Impacts would probably not be more severe than those with natural gas accidents.” Preferred rewording: “Impacts from the CO2 pipeline accident scenarios still need to be assessed in detail. Current regulations treat these pipelines using the same regulations applicable to hazardous chemicals.” (Richard Doctor, Argonne National Laboratory)	Accepted.
4-578	A	29	35			Local impacts could be significant not only to animals but to people, too. (Kimiko Hirata, Kiko Network)	Accepted.
4-579	A	29	36	29	36	Modify the sentence by: "…could be significant since, unless dispersion can occur, a local concentration of…". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted.
4-580	A	29	39	30	4	References? While I don't dispute the statements, they need to be backed up with references. (Jeff Price, California State University, Chico)	Accepted. Reference is IPCC, 2005.
4-581	A	29	47	29	48	How can it be 'appropriate' while at the same time its effectiveness has not yet been established? (Kenneth Möllersten, Swedish Energy Agency)	Accepted. Sentence changed. Remove ‘appropriate’ and cut text after ‘management’.
4-582	A	30	1	30	4	The report "Ocean acidification due to increasing atmospheric carbon dioxide " from the Royal Society (2005) contains relevant information about the impacts of elevated levels of CO2 in the oceans that ought to be referred to. (Kenneth Möllersten, Swedish Energy Agency)	Add as a refernce on P 30, line 1.
4-583	A	30	2	30	4	The Special Report on CO2 CCS also states that 'CO2 effects on marine organisms will have ecosystem consequences' and should also be highlighted in this report to give an appropriate assessment of the risks.	Noted. Information will be added on P 30, line 1 and 2.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Kirsten Macey, Climate Action Network Europe)	
4-584	A	30	7	30	9	The sentence is unclear. Replace "did" by "do"? Replace "useful" by "acceptable"? (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted. 'Did' replaced by 'Does'. And 'useful' by 'acceptable'.
4-585	A	30	9	30	11	The sentence „For example .... might be judged an adequate storage period for policy makers." is speculative and not sound science. It is not part of the IPCC report – sentence to be deleted. (Gabriela Von Goerne, Greenpeace)	Accepted. Delete all sentence in lines 9 to 11.
4-586	A	30	12	30	12	Which reservoir - the total global? (Kenneth Möllersten, Swedish Energy Agency)	Accepted. Add 'specific" before "reservoir".
4-587	A	30	16	30	17	Properly managed CCS is meant to reduce emissions absolutely, so this statement becomes pointless. (Kenneth Möllersten, Swedish Energy Agency)	Accepted. Add 'fossil fuel" before CO2 emissions and remove 'absolutely".
4-588	A	30	21	30	21	Add a sentence: "…would be difficult to control. This is essentially the case for ocean storage. For well-selected ...". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Rejected. Too much information.
4-589	A	30	26	30	26	In the SRCCS it is stated that it is 'likely' that 99% will remain for 1000 yrs (not 'very likely' which is used to describe the probability that 99% will remain one hundred yrs). (Kenneth Möllersten, Swedish Energy Agency)	Accepted. Remove 'very'.
4-590	A	30	26	30	26	start a new paragraph "...after 1000 years." to at least separate a little bit ocean storage from geological storage¡. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted.
4-591	A	30	31	31	23	Could include some examples of projects with R&D issues, both for capture and storage. The paragraph on CO2GeoNet mentionned on p 31 line 33 to 39 could be inserted here. (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Rejected. Adequate example.
4-592	A	30	32	30	44	This paragraph should include information on the three options investigated for capture: post-combustion, oxy-combustion and pre-combustion capture. The examples at the end of the paragraph (FuureGen, BP) are not relevant here, or	Rejected. Examples mentioned on P 28.

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						should be presented differently and complemented by other examples. (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	
4-593	A	30	39	30	40	COMMENT: We suggest that "Japanese Clean Coal Cycle (C3) Initiative" is also sould be described in this chapter together with "Futuregen". REFERENCE: Interim Report of the Clean Coal Cycle (C3) Study Group,"Japan's New Coal Policy Towards 2030" -C3 Initiative Towards the Establishment of the Clean Coal Cycle (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted. Add text and refernces.
4-594	A	30	39	30	40	COMMENT: We suggest that "Japanese Clean Coal Cycle (C3) Initiative" is also sould be described in this chapter together with "Futuregen". REFERENCE: Interim Report of the Clean Coal Cycle (C3) Study Group,"Japan's New Coal Policy Towards 2030" -C3 Initiative Towards the Establishment of the Clean Coal Cycle (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted. Add text and refernces
4-595	A	30	41			It has not been scientifically proven that CO2 CCS will not leak CO2 and will reduce 100% emissions - therefore it is misleading to state that this technology will produce zero emissions. This is a quote from a US government website and not a scientifically proven statement. (Kirsten Macey, Climate Action Network Europe)	Accepted. We will change from zero to 'low emission'.
4-596	A	30	43	30	44	The power plant is on the E-coast of UK not in the North Sea. It is the CO2 which will be pumped by pipeline to an offshore platform in the North-Sea for EOR. (Gabriela Von Goerne, Greenpeace)	Accepted. We will say 'off the coast of UK'.
4-597	A	30	46	31	10	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)	Accepted. Chage sentence to: 'Storage in saline acquifiers is commercially successful under the carbon tax regime of Norway in the Sleipner case".
4-598	A	30	47	30	47	Modify the sentence by: "Injection of CO2 into oil reservoirs for enhanced oil recovery is a mature technology, but…". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted.

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4-599	A	30	49	30	49	Replace "inject" by "store". Say that CO2 injection at Weyburn has started in 2000. Say that the CO2 comes from an industry in the USA and is transported by a pipeline. (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Rejected. Inject is fine and we don't need too much information.
4-600	A	31	1	31	2	Modify the sentence: "The fate of the injected CO2 is closely monitored by an international R&D consortium under the aegis of IEA". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted.
4-601	A	31	4	31	17	add a sentence to say that : saline aquifers offer a huge potential worlwide, but that further research and studies should precise the geological conditions and criteria for selection of appropriate aquifers and sites. This in order to allow either regional evaluation of CCS geological storage or to allow for development of projects. (VARET JACQUES, BRGM)	Rejected. Too much information.
4-602	A	31	4	31	6	It should be stated that the Sleipner CO2 storage project has been undertaken due to the economic policy of a CO2 tax in Norway. This is an example of the way in which policy can influence and promote technology options and should be stated to provide readers with the full assessment of how the technology is being implemented. (Kirsten Macey, Climate Action Network Europe)	Accepted. See comment # 597.
4-603	A	31	6	31	6	Add: "Annually, since 1996, approximately…". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted.
4-604	A	31	10	31	10	Modify the sentence by: " Industrial-scale storage in deep saline aquifers has also started in 2004 with the In Salah gas field project in Algeria. The CO2 stripped from natural gas is re-injected into the same aquifer, but outside the boundaries of the gas field. Over the life of the project, it is estimated that 17 Mt CO2 will be geologically stored".(IPCC SRCCS 2005). Then make another sentence for pilot-scale demonstration projects (Nagaoka, Frio). (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Rejected. Does not conform with SRCCS, Table 5.1, P 201.
4-605	A	31	19	31	22	add a sentence to say that : further research and studies shoud allow to better asses storage capacities in coal beds, either for regional evaluation of CCS geological	Rejected.

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						storage or in order to allow for development of local projects. (VARET JACQUES, BRGM)	
4-606	A	31	21	31	21	the European project Recopol should also be mentioned in this context (Marco Mazzotti, Institute of Process Engineering)	Accepted. It will be added to the text.
4-607	A	31	23	31	23	a § should be added here to express the view that : a major challenge for further research would be to develop geological sequestration in sites really favourable for in situ mineral sequestration. Such conditions are met notably in basaltic formations. Such formations are well developped, at proper depth, in trap basaltic series. Such formations are well developped in several countries like india, Brazil, Ethiopia, USA or Russia. (VARET JACQUES, BRGM)	Rejected. We need a reference to use this information.
4-608	A	31	24	31	39	Comment: The main drivers for international (worldwide) collaboration are the IEA GHG programme and CSLF. International collaboration occurs also through various R&D projects, but this kind of collaboration should be rather mentionned in the section 4.3.1.2.2. (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted. Change line 25 to read as 'International…..as the IEA GHG R&D Programe that is monitored in Weyburn storage project…'
4-609	A	31	25	31	31	The IEA GHG R&D Programme deserves to be mentioned alongside with the CSLF. It is a significant effort. (Kenneth Möllersten, Swedish Energy Agency)	Accepted. See above.
4-610	A	31	33	31	34	Modify the sentence by: " CO2GeoNet is another research partnership devoted to geological storage of CO2. This European Network of Excellence, co-funded by EC, involves 13 institutes and more than 100 research scientists. (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted first sentence. Second rejected. Too much information.
4-611	A	31	36	31	36	Insert: "…the development of site geological models, predictive …" (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted.
4-612	A	31	41	32	5	does the literature say anything about regulatory barriers to drilling CCS wells such as protected areas, permitting issues, areas with water shortages, etc.? (Casey Delhotal, USEPA)	No lierature is available.
4-613	A	31	41			The section should mention also legal implications with respect to accidental	Accepted. Change line 42 to read: ' Onshore

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						release of CO2 emissions (e.g. liability issues). (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	storage and accidental release is subject almost…'
4-614	A	31	42	31	45	"Also ´onshore` storage will be subject to international frameworks like UNFCCC and the Kyoto Protocol. " (Martina Jung, (Freelance))	It is already covered. See line 44.
4-615	A	31	48	31	48	What is meant by 'definition and policy'? (Kenneth Möllersten, Swedish Energy Agency)	Accepted. Delete 'definition' in line 48.
4-616	A	31	49	32	7	The first and the last items in the bullet list seem loosely connected to the issue of legal and regulatory framework. The last item sounds very generic and vague. (Kenneth Möllersten, Swedish Energy Agency)	Accepted. Delete the first bullet. For the last bullet say: Establish CCS as a climate mitigation technology.
4-617	A	31	49	32	14	Devising and introducing regulation for CCS, particularly geological on shore, will take considerable time (HEDGER MERYLYN, Environment Agency)	Rejected. Too much information.
4-618	A	32	0			There is no mention in this section of the contribution nuclear energy could make to mitigating climate change if it is expanded significantly. Some references that the authors may consider here are: William C. Sailor, David Bodansky, Chaim Braun, Steve Fetter and Bob van der Zwaan, A Nuclear Solution to Climate Change?, Science, Vol. 288, 19 May 2000, pp. 1177-1178. Bob van der Zwaan, "Nuclear Energy: Tenfold Expansion or Phaseout?", Technological Forecasting and Social Change, 69, 287-307, 2002. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	Accepted This message is at least implicitly given in this section as well in other parts of Ch4. The significance of broader utilization of nuclear power as well as more efficient utilization of uranium resources in longer term will be described more explicitly
4-619	A	32	0			4.3.2. Nuclear Energy. On uranium reserves: "The world has two and half million tonnes of known uranium reserves (uranium being the only part of the nuclear fuel cycle in which the Union is not self-sufficient) at a market price lower than US$ 80 a kilo, representing 40 years' demand at present rates of consumption (the current market price is around US$ 20 a kilo). Further known resources come to about 850	Accepted The mentioned information will be studies in addition to the already employed data source(NEA/IAEA information contained in "RedBook"2003). It is relevant to consider

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						000 tonnes (corresponding to 15 years' demand) at the same price and are mainly located in Australia, Kazakhstan, Uzbekistan and Canada." Source: European Commission Green Paper of 29 November 2000 "Towards a European strategy for the security of energy supply" [COM(2000) 769]. http://www.europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=COMfinal&an_doc=2000&nu_doc=769 (Arjette Stevens, De Koepel)	also resources with higher than US$ 80/kg. An important further fact is that the share of raw uranium is minor part of the total power production price by nuclear energy.
4-653	A	32	0	33		Nuclear p32 The overall description of nuclear technology is far too optimistic. The authors draw a very positiv view about the latest developments in the nuclear sector and the future development. the overall share of nuclear will drop - this is already common sense - because new reactors will not be on line as fast as old one have to shut down and especially won´t follow the raising global energy demand. page 33 first chapter even talks about "closed fuel cycle systems" and fast breeder reactors! (Arjette Stevens, De Koepel)	Taken into account In this section no rapidly growing scenario is presented for nuclear. Both restrictions for the increases role of nuclear energy and the potential future possibilities as significant means to mitigate GHG emissions are discussed in this section. The advanced systems (Gen4) are indicated to gradually enter trhe market beyond 2030 (cf. Fig. 4.3.9).
4-620	A	32	2	32	2	Delete sentence with "inevitable contaminants…" as this is not true (food grade CO2 can be produced removing these contaminants. Contaminants in the raw stream of CO2 coming from a postcombustion or oxyfuired capture system would not be H2S and hydrocarbons (SO2,NOx). (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	?????????????? This comment applies non-nuclear energy sources
4-621	A	32	15			Section 4.3.2 -On nuclear power, the analysis is well informed and balanced, including the economics of Uranium resource, the economics of existing plants, the assessment of safety, the situation of nuclear waste and its solution, the timeframe distinction between Generation III and IV, and the significant impact of nuclear power on worldwide CO2 emissions. It seems that, instead of giving a very wide range for economic cost of available technologies, the draft could suggest that where and when (and only in these cases)	Accepted Possibilities to consider these suggested additional aspects will be studied after having got acquaintance to the new references. Difficult to make a prognosis of the rate of nuclear power expansion. The three nuclear growth scenarios of the new WNA-study

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						appropriate industrial and public policies are implemented (including public acceptability, strong safety authorities, etc…), the expected cost of G III available technologies is quite attractive (let us say 3-4 US cents/kWh) and allow for a real development of nuclear power with due consideration to Uranium resource, enhance its place in the worldwide electricity mix (20-30% ?) and thus be one significant element (among others) of a strategy to reduce CO2 emissions (assessment of costs can be in accordance with the analysis provided by NEA-OECD-IEA (2005) and used by the draft. Adding Chicago University, 2004 and WNA 2005 as references might be useful). References Chicago University, 2004, "The Economic of Nuclear Power"; A Study Conducted at The University of Chicago, for the US Department of Energy. August 2004. WNA 2005, "The New Economics of Nuclear Power", World Nuclear Association. 2005 (Jean-Yves CANEILL, Electricité de France)	could b e referred to and shortly discussed.
4-622	A	32	16			Description in this section (4.3.2) as a whole looks to be too partial to nuclear energy. Environmental impacts by nuclear energy should also be mentioned. Firstly, utilization of uranium resource causes emission of heats and toxic substances into the environment. Secondly, nuclear energy depends on consumption of fossil fuels. Countries with a large number of nuclear power plants consume fossil fuels and increase CO2 emission. Thirdly, severe nuclear pollution problems occur in developing countries because of dumping of slag from uranium mining. (Kenichi Oshima, Ritsumeikan University)	Taken into account A short discussion of safety and environmental impacts will be added. The life cycle results include the CO2 emissions in the nuclear fuel cycle due to use of fossil fuels in various fuel cycle stages.
4-623	A	32	16			The section should also provide info on the following aspects: a) cost figures (per	Taken intro account

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						kW, as well as per kWh based on LCA) of nuclear energy compared to other electricity generation technologies b) classification of existing plants on global basis according to the year of construction, the technology applied and the geographical area where they are located. Furthermore, apart from China, the section should provide whatever info is available on the official planning in other countries as well (e.g. India) with respect to the future development of nuclear energy. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	a) The cost comparison is presented in section 4.5.4 b)reference to IAEA/WNA data regarding additional information on existing facilities can be made
4-624	A	32	16	35	16	General comment: Insert a sub-chapter on risks of nuclear energy (like in 4.3.1.2.1), with Chernobyl as one example for accident (Gabriela Von Goerne, Greenpeace)	Taken into account Additional discussion on safety (accident risk) and environmental impact can be included in section 4.3.2
4-625	A	32	17			• P.32. Section 4.3.2. There is little reference in this section on the economics of nuclear power in particular in liberalized energy markets. Market liberalization has a specific impact on the potential growth of nuclear power industry. Findings from the literature on this would usefully complete the picture on the relative interest of nuclear power as compared to other technologies. A reference to market liberalization is given in section 4.5.5 p. 58 L. 34. It should be stressed also in other sections. (Philippe Tulkens, TERI School of Advanced Studies)	Taken into account The cost comparison is presented in section 4.5.4. Market liberalisation, industry owned NPPs and benefits to carbon-free sources owing to emission trading are/will be brought up in that or in other sections of Ch4.
4-626	A	32	19			IAEA PRIS, 2005 not in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted That reference will be added and cited.
4-627	A	32	23	32	23	All energy resources also require the processing of materials. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	Accepted The text will be clarified
4-628	A	32	23	32	24	This should read "the nucler fission option brings special concerns with respect to nuclear safety, waste and particularly weapons proliferation that need to be resolved to the satisfaction of the public and governing authorities." To suggest that there is no technical basis for concern about nuclear weapons proliferation in a	Accepted The text will be reformulated to account for the suggestion and comment

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						world substantially powered by breeder reactors is not credible. (Robert Goldston, Princeton Plasma Physics Laboratory)	
4-629	A	32	23	32	23	It is proposed to delete "public" because concerns also have been expressed by governments as well as by experts. (Radunsky Klaus, Umweltbundesamt)	Accepted
4-630	A	32	23	32	24	The public is not concerned only with proliferation of nuclear weapons, but most of all with potential nuclear accidents and disposal of nuclear wastes. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Taken into account Additional discussion on safety (accident risk) and environmental impact can be included in this section. Discussion on waste disposal is already included.
4-631	A	32	24	32	28	There is no scientific assessment to suggest that nuclear power is a sustainable energy technology. In considering the definition of sustainability it should not only consider the greenhouse emissions but whether the resource has social and environmental impacts and will meet the needs of people without compromising future generations. This is not likely for nuclear power with the problem of managing nuclear waste. This text suggests that there are no adverse environmental impacts associated with this technology. Nuclear power will never be able to meet sustainability goals because every stage of the nuclear cycle produces waste and will continue to pollute for many thousands of years. The references in this chapter only identify the Nuclear Energy Agency, I believe it would be more appropriate to find scientific assessment report to find scientific evidence that supports claims rather than repeat messages from the nuclear industry. There are many scientific surveys which identify people's opinions on nuclear power and these should be referenced to in this chapter rather than what the nuclear industry believes people's opinion on nuclear should be on. (Kirsten Macey, Climate Action Network Europe)	Taken into account The reduction of impacts on future generations is a specific in international & national safety criteria developed e.g. by IAEA and in the Joint Convention on spent fuel and radioactive waste management. The need of better social acceptance is mentioned in the FOD-version as a condition to meet more fully the sustainability goals.
4-632	A	32	24	32	24	There are also public concerns about safety and waste to add to the concern about proliferation of nuclear weapons. (Kirsten Macey, Climate Action Network Europe)	Taken into account Additional discussion on safety (accident risk) and environmental impact can be included in this section. Discussion on waste disposal is

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							already included.
4-633	A	32	24	32	25	The degree of contribution to sustainable development of a mitigation option is a function of objective parameters (e.g. reduction potential, availability along time etc.), while social acceptance is a political point of view and depends on a number of factors that are not all of an objective nature. For example, the value that one individual puts on the (even small) risk of a nuclear accident is very different from the respective one of another individual. Therefore, the opposition of a large part of the public towards nuclear has an objective basis as well, i.e. the potential risk of a nuclear accident which will harm, if it happens, human health, natural resources etc. The same is true for another impact of nuclear energy which affects social acceptance, i.e. the disposal of nuclear wastes, which may take place in sites/under conditions that do not safeguard environmental protection. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Taken into account The decision-making has to form a balanced view considering both the potentially harmful effects (in collective fashion) and the significant mitigation potential for avoiding GHG emissions with perspective to those aspects of other energy forms as well.
4-634	A	32	25	32	28	This should read "the general public and governing authorities will have to put ... into perspective with the issues presented by other non-CO2-emitting energy sources and the prospect of uncontrolled global climate change, in order to create the conditions for properly balanced decision-making on the role of nuclear fission power in sustainable development." (Robert Goldston, Princeton Plasma Physics Laboratory)	Accepted The suggestion will be considered in reformulating the present version into SOD
4-635	A	32	26	32	26	What is exactly meant by “general public” ? We do not understand the purpose of the sentence. For sure, the analysis needs to be comprehensive and all impacts have to be taken into account, from economic, social, ethical and political perspectives. Is the goal of the sentence to state that the general public is characterised by a misperception over the proliferation of nuclear weapons ? If so, it should be clearly stated and documented. (Peter Wittoeck, Belgian Federal Administration)	Taken into account The idea is that the views of general public need to be respected. The decision-making needs to consider both benefits (such as GHG mitigation potential) and drawbacks of different energy forms.
4-636	A	32	30			electricity produced -> electricity generated REASON: "generation" is the commonly used word rather than "production" in this	Accepted Needs to be consistent over the whole

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						context. (Yasuhisa Yaoita, Global Industrial and Social Progress Research Institute)	chapter4
4-637	A	32	30		31	Total lifecycle emissions by nuclear electricity generation of 1-11 gCeq/kWh. Source of these values? How are these values calculated? Two comments: • The cited lower value of 1 gCeq/kWh certainly is too low: see Appendix B. • Specific CO2 emission strongly depends on ore grade, rapidly rising with decreasing grade when ores are used lower than 0.2% uranium. See remarks in comment on p. 32 line 43 and Appendix B (referred to in ch4,p.19,l.15 comments). (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Taken into account The main source is the WEC2004 LCA review study. The range is based on the reviewed studies. Some additional references will be added and cited in this section and/or in section 4.4.1 (Fig. 4.4.3)
4-638	A	32	30	32	31	The text refers to figure 4.4.4. (4.4.3, we presume). This Figure should be explained because it seems to illustrate the results of alternative (high – low) scenarios that are not described. (Peter Wittoeck, Belgian Federal Administration)	Accepted Figure 4.4.3 is meant; cf. also response to previous comment (4-637). Some aspects of the approach followed in WEC2004 review will be mentioned,
4-639	A	32	30	32	33	The statement on life-cycle analysis does not appear to be appropriately referenced for scientific assessment, it is unclear where the scientific analysis of the statement that the life-cycle of nuclear power is similiar to renewable energy comes from. Secondly, life-cycle analysis must make accurate comparisons. The life-cycle of nuclear must include the energy required for mining, enrichment, transport, energy to build and power the reactor, reprocessing and finally storage or the radioactive waste. http://www.nrel.gov/ncpv/thin_film/docs/fthenakis_alsema_dewild_ieee_pvsc_2005.pdf (Kirsten Macey, Climate Action Network Europe)	Taken into account, The primary reference (WEC2004b) is a review of appropriately documented LCA-studies. Similarity to renewable energy refers simply to the fact that in both cases there are no stack emissions from the power plant itself.. The full fuel cycle is considered for nuclear as well as for other energy sources. As concerns the accuracy of comparison, the variability of emissions based on plant-specific and fuel-cycle option and ore-specific features have to be accounted for as done in ref. WEC2004b.
4-640	A	32	30			The figures for gCO2/kWh are very low (note by the way that they are different from those in Figure 4.4.4). Is this based on an assessment of the variety of studies available? Older studies quoted figures of about 100 gCO2/kWh and higher which	Taken into account Figure 4.4.3 and the text use different units. The interval indicated refers to variability

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						probably was too high, but this is really the other extreme. (Blok Kornelis, Ecofys)	among the results of the reviewed case studies in WEC2004b.
4-641	A	32	31			Text refers to wrong Figure number: should be Fig 4.4.3, not Fig 4.4.4. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Accepted
4-642	A	32	31	32	32	The figure of the lowest CO2 emission from nuclear power is based on WEC 2004b. WEC 2004b is based on EPD (2004a), Vattenfall AB Generation Nordic Countries Certified Environmental Product Declaration of Electricity from Ringhals AB (http://www.environdec.com/reg/026/Chapters/Dokument/EPD-Ringhals.pdf) and EPD (2004b) Vattenfall AB Generation Nordic Countries Certified Environmental Product Declaration of Electricity from Forkmarks Kraftgrupp AB (FKA) (http://www.environdec.com/reg/021/Chapters/Dokument/EPD-FKA-2005.pdf). However, EPD (2004a) (2004b) do not show the scientific basis including data and formulas for their calculation but just the calculation results. Therefore, from the scientific point of view, at least the lowest case of GHG emissions from nuclear power, 1gCeq/kWh, should be deleted from this sentence. (Kenichi Oshima, Ritsumeikan University)	Taken into account Less emphasis could be paid on the lower end of the interval for example stating that emission are below or equal the upper limit.
4-643	A	32	31	32	31	"Fig. 4.4.4" should be altered to "Fig.4.4.3". (Kenichi Oshima, Ritsumeikan University)	Accepted
4-644	A	32	35	32	46	In this pragraph also the emissions related to the construction of the power plant (use of large amounts of concrete) should be mentioned. To my knowledge this contributes highly to the overall carbon emissions of nuclear power (that is, in relative terms. Of course, absolute emission levels are low, as correctly stated). (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	Taken into account Emissions from producing construction materials have been include for all energy forms in case studies reviewed in WEC2004b
4-645	A	32	38		41	Figure of 1 g CO2eq/kWh: from which reference? This value not backed by empirical data. As argued in Appendix B, the energy requirements of mining and milling (extraction of uranium from rock) and hence the specific CO2 emission, strongly depends on the ore grade. Based on empirical data, the following values of specific CO2 emission of the mining + milling process can be calculated. In this calculation all energy inputs are	Taken into account This particular value corresponds to plant-specific case studies (performed by Vattenfall for Ringhals & Forsmak NPPs) reviewed in WEC2004b. (cf. also comment 4-642 and response to it). In further drafting of this

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						accounted for: direct energy consumption, embodied energy in chemicals and materials, energy embodied in facilities and equipment and for maintenance. Assumptions: burnup of the enriched uranium in the reactor of 46 GW(th).day/Mg, a reload mass of 20.3 Mg and a required mass of natural uranium of 162 Mg. Ore grade Soft ores Hard ores % U3O8 gCO2/kWh gCO2/kWh 0.15 (about current world average) 3 4 0.06 7 12 0.03 15 27 Leaner orers tend to be harder to mill. For example the ores of Olympic Dam in Australia (with grades of 0.06 – 0.03% U3O8) are hard ores. Moreover, Olympic Dam, the largest uranium deposit in the world, is an undergound mine, so the specific energy requirements and CO2 emission may be higher than above calculations, which are based on average values. Ores in Khazakstan, the second largest reources, have grades of 0.02-0.07 % U3O8 and are extracted by ISL (in situ leaching). Environmentally ISL is very damaging and non-sustainable. Its specific energy requirements may be compared with those of convnetional mining and milling of soft ores with the same grades. Uranium deposits in Sout Africa and Namibia have ore grades of about 0.02-0.035 % U3O8. • In the enrichment process alone about 5 gCO2eq/kWh (1.4 gCeq/kWh) is emitted as freon 114. Construction of the nuclear power plants adds at least 14-28 gCO2eq/kWh (4-8 gCeq/kWh). • Moreover, emissions of fluoro- and chloro-carbon compounds in the industrial processes needed to convert uranium ore into nuclear fuel are still unknown in the open literature. It is doubtful wether these emissions are ever investigated. From a chemical point of view it seems extremely improbable that the industrial processes of the front end are completely free of emissions of any greenhouse gas (or ozone depleting gas) other than CO2. Lack of actual measurements doesn't mean such emissions are absent.	section the figures presented in this comment will be evaluated and added as an additional reference as well as compared to the case studies reviewed in WEC2004b. Assumptions concerning the Freon leakages during enrichment process need to be checked. In principle the possibility of Freon leakages is also relevant to other energy forms, such as photovoltaics (PV) and liquefied natural gas (LNG) power plant fuel cycle.

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						In my view it is no good scientific practice to adopt non-verifiable statements without question. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	
4-646	A	32	43		46	Avoided emission of carbondioxide 0.7 GtC/yr, or 0.4 GtC/yr. Cited values strongly depend on the grade of the uranium ore (see Appendix B) and some implicite assumptions. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Taken into account As the specific emissions of coal (compared option) are much higher (800-100gCO2/kWh), the variation caused by the grade of uranium ore changes this figure only slightly.
4-647	A	32	43	32	43	Modify the sentence by: "…from coal without carbon dioxide capture and storage, or…" (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted
4-648	A	32	43	32	44	COMMENT: We support the assessment of the greenhouse gas avoidance of nuclear generation globally. Additional references supporting the existing reference can be found in "OECD/NEA, Nuclear Energy and the Kyoto Protocol, 2002" (Jonathan Cobb, World Nuclear Association)	Accepted The proposed additional reference will be included
4-649	A	32	45			electricity production -> electricity generation REASON: "generation" is the commonly used word rather than "production" in this context. (Yasuhisa Yaoita, Global Industrial and Social Progress Research Institute)	Noted Both terms are frequently used. The whole Ch4 should aim to use consistently either of these
4-650	A	32	46	32	49	It is necessary to add another reality of nuclear development. The fact is a lot of countries are planning to withdraw from nuclear power development. This paragraph is too partial to nuclear development because nations expanding nuclear industry are only mentioned. (Kenichi Oshima, Ritsumeikan University)	Taken into account China and India are mentioned because they provide potentially large markets of new power plant. Owing to phase-out and decommissioning of older NPPs most of the nuclear development scenarios include only modest growth if any in the next decade or so.
4-651	A	32	46	32	49	In this paragraph, nations expanding nuclear industry only are took up here.	Noted

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						However, it is necessary to refer to nations planning to withdraw from nuclear power. (Masatake Uezono, Citizens' Alliance for saving the Atmosphere and the Earth)	See response to comment 4-650 above
4-652	A	32	47	32	47	Not only China and India. Also e.g. South Africa. And other countries may soon follow. NYT is not the right reference for this sort of information. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	Accepted Reference to NYT will be replace by another reference
4-654	A	33	1	33	4	The risk and reality of closed fuel-cycle systems should be mentioned in this part. Closed fuel-cycle systems involve reprocessing of spent nuclear fuel that would contaminate the environment with diffusion of radionuclides. Recycling needs more complex paths to handle toxic materials, part of which would be released. In addition, even now there is large amount of surplus plutonium worldwide with no reactor to use. (Kenichi Oshima, Ritsumeikan University)	Taken into account The necessity of reprocessing for closed-cycle systems is mentioned. Growing experience shows that reprocessing can be performed with minor environmental effluent releases within regulatory limits.
4-655	A	33	2	33	5	will' (two times) should be replace by 'may', as it is too strong: there is more uncertainty. Reprocessing, for example, has clearly higher costs than the direct disposal option. See e.g. Bunn, M., S. Fetter, J.P. Holdren and B.C.C. van der Zwaan, "The Economics of Reprocessing vs. Direct Disposal of Spent Nuclear Fuel", Nuclear Technology, 150, June, 2005, pp.209-230. Also, there are no resource requirements for implementing a closed cycle: we have more than enough uranium for a very long time to come: see same article. (This latter remark applies to this whole section, and the reference is essential herein.) Reduction of waste also may be moderate. And reprocessig enhances the risks of proliferation, as plutonium is separated from spent fuel. This paragraph is clearly too positive about reprocessing. Only in terms of very long time periods it may finally be somewhat more sustainable. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	Taken into account The first "will" can be replaced by "have potentially" and the second "will" by "has another objective to". Closed-cycle systems (Gen4) are mentioned as potential longer-term (beyond 2030) option. The higher fuel-cycle costs need to be put in perspective with increasing efficiency of uranium use and the availability and costs of other mitigation options.
4-656	A	33	5	33	5	It is proposed to explain te abbreviation P&T-technologies. (Radunsky Klaus, Umweltbundesamt)	Accepted P&T = partitioning & transmutation
4-657	A	33	7	33	45	When discussing the extraction of uranium (and thorium), it would be good to mention the environmental impact (and safety) of mining and milling. See	Accepted One can add that careful measures are needed

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						http://www.wise-uranium.org/ulite.html#booksenvimp for a bibliography on this subject. In particular, what would be the impact of significantly increasing mining and milling operations worldwide? (Lee Lynd, Dartmouth College)	to restrict the potential (also long-term) environmental impacts
4-658	A	33	10	33	11	If I understand this correctly, you mean to say: "Because only U-235 is used in once-through systems, and U-235 constitutes only 1% of natural uranium, only a small part of the uranium fuel is used in once-throug reactors". I find the current wording a bit unclear. (Danny Harvey, University of Toronto)	Accepted The text will be clarified
4-659	A	33	11	33	15	Description of this part is based on unrealistic dream. It is necessary to add the reality of breeder reactors. Firstly, breeder reactors have severe safety concerns: easy to runaway and difficulty in sodium handling. Secondly, breeding capacity of a breeder reactor is much less than generally and mistakenly understood. Its doubling time can be longer than the lifetime of a breeder reactor. Therefore, it is difficult to bring significant increase of plutonium for commercial use. Thirdly, though extraction of plutonium, which includes weapons grade one, from breeder reactor blankets is relatively easy, it is difficult to extract plutonium from core fuel. In order to extract the plutonium, a special reprocessing facility is thought to be necessary. However, this kind of reprocessing technology has not been realized. Fourthly, there is few FBR in the world because major countries have withdrawn from FBR development. Also there is no practical reprocessing plant designed for FBR spent fuels, which is essential to extract plutonium to use. (Kenichi Oshima, Ritsumeikan University)	Taken into account The needs of technology development will be further emphasized. Variability of U needs in future scenarios need can arise to increase the efficiency of uranium utilization meaning that closed-cycle systems (breeder) need to be introduced. As stated in responses to other comments these advanced systems belong to generation4 and hence much technology development is still needed.
4-660	A	33	13			tens of thousand years -> several thousand years REASON: Figure 4.3.8 shows 2550 to 8500 years. (Yasuhisa Yaoita, Global Industrial and Social Progress Research Institute)	Noted A new version of the figure includes a further option (cf. lines 35-38), In that case “tens of thousand years” is relevant
4-661	A	33	14			‘. . 4 Mt thorium resources (OECD 2001) add considerably to the fuel resources available.’ This statement is fallacious, because it is based on unrealistic assumptions. • The	Taken into account The aspects mentioned will be considered when redrafting the text regarding the

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						thorium-232-uranium-233 breeder cycle exists only as paper concept. Its feasibility is even more doubtful than of the U238-Pu239 breeder cycle, see Appendix C. • Even if the Th232-U233 breeder cycle will function as advertised within the next few years, a logistic obstacle blocks large-scale deployment of this type of nuclear electricity generation, that is the supply of U233. At present only neglible amounts of this nuclide exist in the world. Before the first thorium breeder can start, several tons of U233 are to be bred in special reactors, which are to be constructed and operated in advance of the breeding program itself. Let's assume a highly optimistic scenario in which the first thorium breeder of 1 GW electric power starts up in 2020 with an assumed doubling time of 30 years of its breeder cycle, then the world could have two thorium breeders in 2050, four in 2080, eight in 2110, and so on. After one century the world could have 8 GW electric generation capacity from thorium breeders. For comparison: the present nuclear capacity, providing 2.5% of the world energy consumption, is about 367 GW. To achieve a nuclear generating capacity based on thorium equalling the current capacity, a breeding project lasting at least ten doubling times, 300 years, is required. It may be clear that thorium can't be a significant energy resource during the next 3-4 centuries. In my view the remark on thorium resources as energy resources should be omitted from AR4, or should be disproved in the text. Note: the Appendices A-G are not included in this document and will be sent on request. These comments are based on the study Nuclear power – the energy balance, by J.W. Storm van Leeuwen and Ph.B. Smith, see www.stormsmith.nl Appendix A Energy requirements of extraction of uranium from conventional ores. Dependency on ore grade. Net energy available in the currently known recoverable conventional	potential role (+ time-frame) and the technology development needed for thorium reactors. Also the unproven technological feasibility in general will be more specifically mentioned.(cf. lines 42-44/p. 33)

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						ores. Appendix B Emission of carbon dioxide and other greenhouse gases from the nuclear electricity generation system. Appendix C Breeders and use of thorium. Appendix D Energy flows of the nuclear electricity generation system. Use of primary energy units. Appendix E Extraction of uranium from unconventional resources (phosphates, shales and granites) and from seawater. Appendix F Reprocessing of spent fuel. Addendix G Transmutatation of long-living radionuclides into short-living radionuclides. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	
4-662	A	33	14	33	15	It is required to delete the description about thorium cycle because of its lack of technical feasibility. There are at least two reasons. Firstly, to utilize thorium cycle, it is necessary to convert from Th-232 to U-233. In this process, neutron irradiation by U-235 or Pu is required. This process is quite complicated and is not feasible at this moment. There would be little possibility in the future. Secondly, nuclear industries are not eager to build a thorium cycle reactor, which has little technical and economical competitiveness than conventional uranium reactors. Therefore there is no commercial reactor around the world. (Kenichi Oshima, Ritsumeikan University)	Taken into account See response to the comment 4-661 above
4-663	A	33	16			Cited figures: 4.6 Mt (= 4.6 Tg, see above) uranium, corresponding to 2300 EJ primary energy, and	Rejected This type of calculation of primary energy equivalent is the standard way recommended

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						14.4 Mt (= 14.4 Tg) corresponding to 7200 EJ primary energy. There are several objections against these numbers. • In a reactor with an average burnup of its fuel of 46 GW(th)/Mg enriched uranium – at present the world average is about 33 GW(th)/Mg – 0.6% of the atoms in the natural uranium leaving the mill can be fissioned, or 6 kg per Mg natural uranium. This corresponds to a heat production in the reactor of about 0.49 PJ(th) per Mg natural uranium. In this way calculated 4.6 Tg uranium would correspond with about 2300 EJ heat, and 14.4 Tg with about 7100 EJ heat. Calling the heat generated in the nuclear reactor 'primary energy' and putting it on a par with the energy from fossil fuels is a deceiving way of presentation. The nuclear heat cannot be used otherwise than for raising steam for electricity generation. In its application, nuclear heat cannot be compared with the chemical energy present in fossil fuels and biomass. The only useful energy from nuclear power plants happens to be electricity, comparable with the energy output of hydropower stations and photovoltaic units. The output of these systems should classified as primary energy. Doing so the uranium potential should presented as: 4.6 Tg corresponds with about 680 EJ primary energy, and 14.4 Tg with about 2330 EJ. Regarding the use of primary energy units: see also Appendix D. • It should be noted that these figures refer to quantities of uranium still in the earth's crust. Extraction of uranium from the ground requires an energy input, which depends strongly on the ore grade. See Appendix A. The amount of electricity actually available to the consumer – other than to the nuclear system itself – that can be generated from the 4.6 Tg natural uranium in the ground (the currently known recoverable uranium resources) will be significantly less than the figure of 680 EJ electricity, calculated above. In adition, this electricity is not free of greenhouse gas emissions, because the consumption of considerable amounts of fossil fuels by the nuclear process chain. • The figure of 14.4 Tg uranium in the ground cannot be readily translated into	by the IEA (International Energy Agency). Other definitions could of course in principle be applied, but the IEA definition (way) is used also elsewhere in the report. The reasoning of IEA is presumably based on the fact that a NPP is also a thermal power plant with electrical output about 0.33 x heat power.

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						energy units available to society, because the ore grades and other parameters of the resources, in addition to the 4.6 Tg proved resources, are not known in the open literature. In that respect the figure of 7200 EJ is not verifiable and should be omitted from AR4. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	
4-664	A	33	17	33	21	Table 4.3.1 and this line disagree about the total amount of primary energy available at $130/kg, by over a factor of two. This should be resolved. The comment that this fuel will last for 100 years should be qualified by adding "at current nuclear power production levels." (Robert Goldston, Princeton Plasma Physics Laboratory)	Accepted The disagreement will be clarified (The table may include a broader spectrum of resources or newer data sources)
4-665	A	33	17	33	21	Table 4.3.1 narrows solar thermal to solar thermal electricity alone - and mixes estimates of overall technical potential, such as indicated for PV (1600 Ej/y), and assessments likely to be derived from technico-economic consideration, such as that for solar thermal (1.7 Ej/y). I can't see any justification for a global PV potential to be three orders of magnitude greater than the potential for concentrated solar thermal - this is simply ridiculous. Although the confusion might be in the source, IPCC role is to critically assess the information. What solar technology is more likely to provide more electricity in 2050 or 2100 is hard to guess, but they may end up with comparable contributions: PV is handicapped by its costs and intermittent nature, CSP technologies being cheaper and more easily made guaranteed and even dispatachable, but limited to areas with strong direct insulation unless exported. For example, Aringhoff et al., 2003 (Aringhoff, R., C. Aubrey, G. Brakmann & S. Teske, 2003. Solar Thermal Power 2020, Greenpeace International/European Solar Thermal Power Industry Association, NL - referenced in the chapter as ESTIA), suggest that CSP plants could provide 16,000 TWh of electricity in 2040. Similarly, Table 4.5.3 simply gives a wrong information in stating that solar thermal (again confused with solar thermal electricity only) contributes for 0,04 Ej/y while PV contributes for 0,2 EJ/y. Global PV capacity is slightly more than 1 GW, CSP capacity is 354 MW, but the yearly electrical	The comment is misplaced to page 33 Solar thermal and photovoltaics (PV) are discussed in sections 4.3.3.5&6 (pages 44-45)

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						outputs are close, with some advantage for PV, because CSP plants have higher average insulation and higher average conversion efficiency. In no case can the ratio of outputs be 1 to 5 (indeed, taking usual conventions for primary energy supply, CSP plant would dominate as all heat produced would be accounted for). In any case, both technologies may remain outweigthed by far, as they are today, by solar thermal contribution to heating needs. Active solar thermal collectors in the world have a capacity of about 100 GWh today and an impressive growth rate - especially in China (see also comment on this chapter, page 45). The contribution of passive solar design is probably more important, but information seems scarce. See Werner Weiss*, Irene Bergmann and Gerhard Faninger, SOLAR HEATING WORLDWIDE Markets and contribution to the energy supply 2003, IEA Solar Heating and Cooling Programme. Finally, one may wonder what table 4.5.3 adds to table 4.3.1 (except more mistakes). (Cédric Philibert, International Energy Agency)	
4-666	A	33	19			hundred years … which usage assumed. Current? (Ad Seebregts, Energy research Centre of the Netherlands)	Noted about 100 yrs at the current level
4-667	A	33	23			Figure 4.3.8 What's the meaning of Figure 4.3.8 in AR4? In my view the diagram is misleading in several aspects: • To my knowledge the cited numbers of years of resource availability refer to a constant consumption of uranium at the current rate. In 2004 the uranium consumption rate was about 68 000 Mg/a and the gross nuclear electricity production 9.93 EJ/a. This amounts to 2.5% of the total world energy consumption in 2004 (BP Amoco 2005). At this production level the nuclear share will have diminished to about 1% in 2050. One may wonder what the meaning of this share in the mitigation of anthropogenic climate change can be. • The figures concerning use of fast reactors, the higher two of each block in Figure 4.3.8, are based on technology which has proven to be unfeasible (see Appendix C).	Noted The figure caption needs to be complete. The figure refers to the resource availability at the present consumption level. The figure is consistent with the data presented in Table 26 in the joint NEA & IAEA "RedBook 2003" and the definition of the categories is also the same as in this reference.. The internal energy consumption within reprocessing is not dominant (roughly the same as in enrichment by the less energy intensive centrifuge method).

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						• Technologies involving reprocessing of spent fuel have a large specific internal energy consumption. This fact is not accounted for. • The upper block regards 'proven and probable resources'. Not known are the ore grades and other parameters determining the specific energy requirements of extraction the uranium from the deposits. In view of the fact that the easily discoverable and easiliy mineable uranium resources are being exploited already, new resources probably will have larger specific energy requirements than the currently mined resources. See also Appendix A. I suggest to omit Figure 4.3.8 from AR4. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	
4-668	A	33	23			figure 4.3.8: The figure caption should explain what "conventional" and "non-conventional" mean (Marco Mazzotti, Institute of Process Engineering)	Accepted The figure caption will be expanded to include short definitions to these terms.
4-669	A	33	24			Red Book, 2003 not in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Noted Red Book, 2003 is a nickname and will be replaced by the actual reference = OECD2004a
4-670	A	33	26			Comment: replace "Conventional proven resources" to "Conventional known resources" REASON: OECD/NEA's RedBook indicates "known", not "proven". (Yasuhisa Yaoita, Global Industrial and Social Progress Research Institute)	Accepted The text and Figure 4.3.8 will be changed to refer to "known conventional resources"
4-671	A	33	28			figure 4.3.8: I suggest to delete the item of "Light water and fast reactors". Reason: It is very difficult to explain the item in the chapter although it is indicated in OECD/NEA's RedBook. (Yasuhisa Yaoita, Global Industrial and Social Progress Research Institute)	Accepted Suggestion will be considered. Another category for fast reactors (with full U+Pu recycle) is intended to be added (cf. lines 35-37/p. 33)
4-672	A	33	28			The figure of 22 Mt (= 22 Tg) uranium in phospate minerals is a very debatable	Taken into account The text version is not taking account to large

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						figure as energy resource because of two reasons: • Phosphates are are irreplacebly needed for food production as fertilizer. Because of their chemical properties phospate fertilizers are to be replenished continuously and can hardly be recycled. In view of an increasing demand of phospate fertilizers for food production, one may wonder if it would be wise to use phosphate ores just as energy resources: this would mean discarding the phosphates from the ores, in order to extract the uranium. • The energy needed to recover a kilogram of uranium from phosphate ores may be more than the energy which can be generated from that kilogram of uranium. See also Appendix E. For these reasons the statement on uranium from phosphate ores should be omitted from AR4, or should be disproved in the text. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	extent the unconventional resources (phosphate minerals & uranium dissolved in seawater). For example in Figure 4.3.8 unconventional resources are not included. This aspect will be more explicitly notes in the revision of the text. Concerning phosphate minerals the potential recovery of U out of them is intended to be a minor by-product and does not mean discarding the phosphate for other purposes. The indicated price range in ref. OECD 2004a is not consistent with the claimed large extraction energy needed.
4-673	A	33	29			The remark of '4000 Mt uranium (= 4000 Tg U) present in the oceans' should be left out of AR4, or should be disproved in the text. Above statement suggests this amount of uranium could be considered an energy resource, but it isn't. Even if the extraction systems can be constructed, with dimensions measured in tens of kilometers, the energy requirements of the extraction will be prohibitive. See Appendix E. Apparently in Tables 4.3.1 and 4.5.3 and in Figures 4.2.1 and 4.9.1 uranium unconventional deposits and seawater are included. These figures should be omitted from AR4, or should be disproved in the text, because they are based on hypothetical concepts, without any empirical basis, as is pointed out above. Before classifying these deposits as energy resources, the nuclear industry should at first perform a thourough energy analysis of the extraction of uranium from seawater and other unconventional resources. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Taken into account partially The sentence on uranium in seawater can be made qualitative an d refer to this option as a distant possibility having very high extraction energy needed and hence high unit price. <u>Rejected</u> In Figures (4.2.1 and 4.9.1) proven and probable (i.e. not unconventional) uranium resources are employed (cf. Figure 4.3.8) either in present type LWRs (about 7500 EJ) or in closed-cycle FBR-systems (225000 EJ = 30x7500 EJ). Table 4.3.1: the higher figure refers to use in fast reactors; not to the use of unconventional resources. Table 4.5.3: The footnote 4 needs to be revised "…recycled in fast reactors"
4-674	A	33	32	33	38	From the text breeder reactors seem to be the solution of all our energy problems. I	Taken into account

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						believe it would be helpful at this point to clarify the state of development of the technology and the drawbacks that limit its deployment. (Marco Mazzotti, Institute of Process Engineering)	The closed-cycle fast reactor belong to so called Generation 4 nuclear technology concepts and their broader exploitation is expected to take place beyond 2030 (cf. Figure 4.3.9) and extensive research and technology development is still needed.
4-675	A	33	36			The figure of '180-fold' must be an error. An advanced LWR can fission about 0.6% of the atoms in natural uranium. 180x0.6% = 108%. The correct number might be '80-fold' Apart from this error, the cited numbers are debatable. As pointed out before, the feasibility of the breeder cycle is doubtful, at best (Appendix C--Referred to in comments on p. 33 line 14), so any conclusion based on large-scale implementation of breeders should be classified as hypothetical, without practical significance for IPCC scenarios during the next 50-100 years. The same practical, logistic problem arises as with the thorium breeders: the supply of plutonium in this case. To illustrate the problem, we assume a world fissile plutonium inventory of 100 Mg in 2006 and a doubling time of 30 years (at the present state of technology the doubling time would be nearly 90 years, if it works). If the world starts construction of breeders in 2006 and the breeder cycle works as advertised, the world could have about 50 breeders in, say, 2015 generating 50 GW electric power. In 2045 the world could have 100 GW breeder power, 200 GW in 2075, 400 GW in 2105, and so on. If we double this number, assuming plutonium breeding from LWRs, the total capacity in 2105 still would be only 800 GW, about two times as much as the world nuclear capacity in 2006. In my opinion the figures of energy resources based on breeder technology are practically meaningless, and should be omitted from AR4, or should be disproved in the text. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Taken into account (partially) This factor (180) is based on reference OECD 2002. Owing to repeated recycling of both U and Pu as well as breeding the indicated factor can (ideally) be achieved thus exceeding the inverse of the natural content (0.72%) of U-235 in natural uranium. In the revised text a variation interval (e.g. 80-180) for the ratio discussed can be included instead of a single (ideal) value. Furthermore, the long time interval needed will be emphasized in the revised text. However finally, in longer tern, a choice needs to be made whether to start exploiting leaner uranium ores with larger environmental disturbances and hence more extensive countermeasures or to gradually start using reactor concepts utilizing the uranium more efficiently. The condition to the above is that the mentioned restrictions (proliferation, waste disposal etc) to broader social acceptance could be overcome.

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4-676	A	33	40			Nucrear power production -> Nuclear power generation REASON: "generation" is the commonly used word rather than "production" in this context. (Yasuhisa Yaoita, Global Industrial and Social Progress Research Institute)	Noted Both terms are frequently used. The whole Ch4 should aim to use consistently either of these
4-677	A	33	40			I suggest to replace "three times" to "as same". Reason: RedBook argues that 4.5million tons of thorium exists. (Yasuhisa Yaoita, Global Industrial and Social Progress Research Institute)	Accepted The sentence will be modified additional resources of thorium (4.5 Mt) stated
4-678	A	33	40	33	44	It is required to delete the description about thorium cycle because of its lack of technical feasibility. There are at least two reasons. Firstly, to utilize thorium cycle, it is necessary to convert from Th-232 to U-233. In this process, neutron irradiation by U-235 or Pu is required. This process is quite complicated and is not feasible at this moment. There would be little possibility in the future. Secondly, nuclear industries are not eager to build a thorium cycle reactor, which has little technical and economical competitiveness than conventional uranium reactors. Therefore there is no commercial reactor around the world. (Kenichi Oshima, Ritsumeikan University)	Taken into account Cf. responses to comments 4-461 & 4-662
4-679	A	33	46	34	18	It should be added in this section that emissions of radioactive substances and its impact from reprocessing is proven to be more than once-through. See WEC 2004b, p.27. (Kenichi Oshima, Ritsumeikan University)	Noted This suggestion will be considered when redrafting the text for reprocessing & separation (p.34/lines 10-16)
4-680	A	33	46			In order to follow a balanced approach of this controversial issue, the section should not only give examples of countries/regions which allow nuclear waste disposal under specific provisions, but also countries/regions where such kind of disposal is not allowed. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Taken into account The present text later (p. 34/lines 13-18) mentions that some countries are postponing their decisions on high-level waste repository development (Netherlands or Canada etc could be mentioned there as examples)
4-681	A	33	48	34	9	Costs and long term safety of geological disposal are never proven where geological structure of the earth is always in change. Once nuclear wastes are disposed underground irretrievably, there would be no measure to guarantee that no	Taken into account Presently, the safety requirements in many countries for high-level waste/spent fuel

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						soil and water would be contaminated. (Kenichi Oshima, Ritsumeikan University)	repositories include the requirement that these wastes should be able to be retrieved if necessary.
4-682	A	34	1		8	The text about geological repositories may suggest a solution is at hand. In fact the 'solution' of the problem to isolate all radioactive wastes from the biosphere exists only on paper. After more than half a century of nuclear energy generation still no safe practical solution exists to mitigate the potential dangers of nuclear technology. The waste problem should be solved in a safe and truly sustainable way before nuclear power could be incorporated in scenarios of future energy supply. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Taken into account The need of better social acceptance is mentioned as one of the conditions to meet the sustainability goals in 2nd paragraph of section 4.3.2. A few countries are mentioned where progress has been achieved to get improved social acceptance. First sentence (p. 33/line 48-50) will be revised.
4-683	A	34	5			LWR fuel should be High-level Waste (Michael Bowman, GE Global Research)	Noted Term "spent LWR fuel" will be used
4-684	A	34	7			Insert: . The Nuclear Waste Policy Act (NPWA, ref?) places a statutory limit of 70,000 metric tons of waste that may be stored at Yucca Mountain, and the Environmental Protection Agency has set a one million year standard for the control of radioactivity released from Yucca Mountain (ref?). The Yucca Mountain repository is not expected to begin accepting high level waste until after 2015. (Michael Bowman, GE Global Research)	Accepted Suggested text will be adopted as shortened.
4-685	A	34	10	34	18	Replace with: Spent nuclear fuel high-level waste is typically composed of about 95% unutilized uranium, about 4% fission products, and about 1% transuranic actinides, such as plutonium, neptunium, and americium. The fission products are highly radioactive but relatively short-lived, with typical half-lives of under 100 years. The transuranic actinides typically have much longer half-lives and are primarily responsible for the long-term radiotoxicity of high-level waste. In the once-through fuel cycle, such as that presently practiced by the United States, spent nuclear fuel is allowed to cool in pools of water for at least a decade and is then intended for final disposal in a high-level waste depository. In a limited-recycle fuel cycle, such as that presently practiced by Europe, the mass of high-level waste	Taken into account Unfortunately the available text space does not allow the inclusion of all these useful explanatory details. These textbook-type details could be attempted to be mostly covered by citing an appropriate reference (needs to be chosen).

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						is reduced and the uranium supply is slightly extended through the PUREX (Plutonium and URanium EXtraction) process. The PUREX process is a commercially-mature solvent extraction process that selectively extracts pure uranium and pure plutonium from the spent nuclear fuel. The extracted uranium is stored for eventual reuse or disposal as low-level waste. The extracted plutonium is mixed with natural or depleted uranium to form Mixed OXide (MOX) recycled fuel. Although technically feasible, spent MOX fuel is not presently recycled. The remaining high-level waste from the PUREX process, consisting primarily of fission products and minor actinides, is then compacted and "vitrified" (melted with other ingrediants to form a glass) and placed into canisters that are appropriate for long-term disposal. (Michael Bowman, GE Global Research)	
4-686	A	34	10		13	Reprocessing as a method of volume reduction of radioactive wastes is a fallacy. In fact the volume of the highly radioactive wastes increases vastly. The spent fuel mass, containing about the whole Periodic System of the elements, is dissolved in a large volume of boiling nitric acid. The fuel cladding hulls of Zircalloy, still containing a appreciable part of the spent fuel remains undissolved. These hulls cannot be vitrified. All volatile fission products are discharged into air. In addition a significant part of the radioactive soluble substances is released into the sea. That's the reason why reprocessing plants are located at the sea shore. Only those nuclides compatible with boroslicate glass or other ceramic material can be vitrified. Summarized: only a part of the radioactive material in spent fuel ends in vitrified material. See also Appendix F(Referred to in comments on p. 33 line 14) (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Noted The other waste streams (intermediate waste) can be mentioned. The need of technology development for advanced reprocessing and separation for Gen4 closed-cycle systems can be further emphasized.
4-687	A	34	10	34	18	It is necessary to add the following sentence. Though high level waste volume can be reduced by the reprocessing, the total amount of radioactive waste will never decrease even if the spent nuclear fuel is reprocessed. Total amount of radioactivity of spent fuels would not differ even if they were reprocessed. Besides, reprocessing process would add the volume of contaminated materials because wastes would be	Noted See response to similar comments. The separated U and Pu will not be contained in HLW..

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						produced by operating of reprocessing facilities, which itself would be contaminated and be decommissioned. (Kenichi Oshima, Ritsumeikan University)	
4-688	A	34	13		16	Transmutation of long-living radionuclides into short-living radionuclides is a fallacy as well. A crucial part of the transmuter system is complete separation of a highly radioactive material into a large number of fractions: an advanced version of reprocessing of spent fuel. Even if the transmutation system works as adverised, it will take centuries to reduce the radioactivity of transuranic elements with a factor 10-100. Moreover, not all long-living radionuclides can be transmuted into short-living radionuclides. See Appendix G (Referred to in commrnts on p. 33 line 14) (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Taken into account The need of extensive further development of P&T technologies will be emphasizes. The key background reasons (e.g. better resource utilization) will be mentioned as well.
4-689	A	34	14	34	15	Transmutation of radionuclides is unrealistic because it just converts them into other kinds of nuclides, with shorter or longer half lives, instead of eliminating them. Also, transmutation will require large energy input. (Kenichi Oshima, Ritsumeikan University)	Taken into account See response to above comment (4-688). The key issue is that by converting most significant nuclides to shorter-lived ones the total amount of radioactivity decreases more rapidly.
4-690	A	34	16	34	18	This sentence 'As a result it is appropriate to postpone the detailed development of geological disposal systems□□□' should be deleted because it is a controversial issue and still open to discussion. At the present time, it is too early to judge for IPCC. Furthermore it is not consistent with the previous paragragh explaining ongoing projects in Oskarshamn and Yucca Mountain . (Ryota OMORI, Japan Science and Technology Agency)	Taken into account The first sentence will be modified as follows: Meanwhile the detailed development of geological disposal system and the site selection of repositories have been postponed Last part of the original sentence is thus omitted. .
4-691	A	34	16	34	18	Comment: The sentence in line 16-18 should be deleted ("As a result it is appropriate to postpone the detailed development of geological disposal systems and the site selection of repositories because their safety requirements are then less	Taken into account See also response to above comment. The suggested text replacement here will be

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						stringent"), or replace to "It is appropriate to continue the development of the alternative techniques because they reduce the long-term environmental impacts of geological disposal systems." Reason: While alternative techniques including separation and transmutation are being developed in some countries they are in basic research phase, and even when such techniques are commercially in practice, disposal systems themselves will still be necessary. Accordingly, the development of geological disposal systems and the site selection of repositories are under way in many countries in reality, and they are not being postponed. Reference: OECD/NEA□1999□□Strategic Areas in Radioactive Waste Management (Yasuhisa Yaoita, Global Industrial and Social Progress Research Institute)	considered as well in redrafting.
4-692	A	34	16		18	Which source this statement comes from? In my opinion this is an alarming statement regarding nuclear energy, and is not compatible by any means with any definition of sustainability. At present, in 2006, after more than 60 years of research and tens of billions of dollars spent, there's no solution in sight to the problem of radioactive wastes. All 'solutions' mentioned before only exist on paper and do so for the past 60 years. This statement shows clearly that the nuclear industry doesn't intent to pay for a safe solution. In fact it means: we leave this unsolvable problem to the next generations: our children and grandchildren. Based on this statement alone, nuclear power should be excluded from any sustainable energy scenario for the future. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Taken into account See responses to the previous comments. Most countries share the view that progress in waste management and disposal is crucial for meeting sustainability goals. In contrast some countries have chosen to postpone the disposal development.
4-693	A	34	16	34	18	This sentence should be deleted from this section. It is wrong to leap to the conclusion because there is no description regarding safety on disposal of radioactive wastes in this section. (Kenichi Oshima, Ritsumeikan University)	Taken into account The sentence will be completely revised based on this and other similar comments.

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4-694	A	34	16	34	36	It's difficult to leap to this conclusion, because there is no discussion concering safety on disposal of radioactive wastes in this section, This conslusion is a leap in logic. (Masatake Uezono, Citizens' Alliance for saving the Atmosphere and the Earth)	Taken into account See above comments. Safety will be mentioned as the prime objective in existing international/national criteria
4-695	A	34	20	34	30	The enrichment of uranium-235 for fuel manufacture and the separation of pure plutonium from spent fuel via the PUREX process are often viewed as the critical steps in the nuclear fuel cycle in terms of potential nuclear weapons proliferation. Therefore, comprehensive safeguard activities have been established. The Treaty on Non-Proliferation of Nuclear Weapons (NPT) is at the centre of the international regime and has been signed by nearly 190 states. Compliance with the terms of the NPT are verified and monitored by the International Atomic Energy Agency (IAEA). In addition to various international control actions, one of the key objectives in the development of next generation nuclear reactors and advanced fuel cycle technologies is the improvement of proliferation resistance. (Michael Bowman, GE Global Research)	Accepted Suggested formulation clarifies the message.
4-696	A	34	21	34	30	It should be added in this paragraph that plutonium produced in breeder reactors is weapon-grade and, therefore, utilization of breeder reactors accompanies risk of proliferation of nuclear weapons. (Kenichi Oshima, Ritsumeikan University)	Taken into account As indicated, one of the key objectives of Gen4 is the improvement of proliferation resistance in advanced reactor and fuel cycle systems.
4-697	A	34	28			yes, it is built up, but is it not inaccessible as long as the spent fuel is not reprocessed? (Danny Harvey, University of Toronto)	Noted Comment is unclear. Probably meant; “is not accessible as long as SF is not reprocessed. Therefore carefully controlled reprocessing and control of separated plutonium can be considered a better solution.
4-698	A	34	30	34	30	What kind of vulnerabilities? (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Taken into account The text refers to the need of careful safeguards control actions,

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4-699	A	34	31			Why not 'Safety' paragraph? (Ad Seebregts, Energy research Centre of the Netherlands)	Noted A separate paragraph on safety and environmental impacts will be added.

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4-700	A	34	32	35	16	In these paragraphs more could be expanded, or at least mentioned, on attempts to make new reactors more sustainable. In this entire section, nuclear energy could be more set in the context of sustainable development. There are multiple references on this. To mention just two, plus the references that are being used therein (among which notably from the IAEA and NEA): Bruggink, J.J.C. and B.C.C. van der Zwaan, "The role of nuclear energy in establishing sustainable energy paths", International Journal of Global Energy Issues, vol.18, 2/3/4, 2002. Rothwell, G. and B.C.C. van der Zwaan, "Are light water reactor systems sustainable?", The Journal of Energy and Development, vol.29, no.1, 2003, pp. 65-79. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	Noted Possibilities to further improvement of discussion of sustainability aspects of nuclear energy and the role og Gen4 concepts will be considered in redrafting.
4-701	A	34	50			change "blocking" to "block" (Danny Harvey, University of Toronto)	Accepted
4-702	A	35	7			you should first introduce breeder reactors and compare them in general to the other kinds, before describing the different kinds (Danny Harvey, University of Toronto)	Noted Earlier in this section (p. 33/lines 32-34) breeder is very shortly described. A very short "introduction" is probably worthwhile here as well.
4-703	A	35	10	35	11	Besides electrolysis and thermo-chemical water splitting processes, steam reforming process should be added (IAEA-TECDOC-1085: Hydrogen as an energy carrier and its production by nuclear power Chapter2, p.17 http://www.iaea.or.at/inis/aws/htgr/abstracts/abst_30027279.html) . It is one of the most feasible and economical option of nuclear hydrogen production. Though it consumes methane or coal as materials, its energy efficiency could be higher than normal steam reforming processes. (Ryota OMORI, Japan Science and Technology Agency)	Taken into account It may be more appropriate to expand the discussion of hydrogen production technologies in section 4.4.2.2 and have a cross reference here.
4-704	A	35	18	35	28	This section has a number of technical errors and casual judgments. Given the size of the world fusion R&D program, more description should be provided. See the attached proposed text, labeled "Fusion Energy.doc". This should be an independent subsection of an overall Nuclear Energy section, parallel with the section on fission, because the issues and the stage of development are so different, but the level of investment (particularly with ITER) is significant. This would be similar to the division of Renewable Energy into subsections. (Robert Goldston, Princeton Plasma Physics Laboratory)	Taken into account The limited text space available does not allow major expansion of the description of nuclear fusion. However, too vague expressions will be modified taking into account the suggestions received.
4-705	A	35	18			The section should also mention since when the scientific efforts on nuclear fusion date and what are the results obtained up to now. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS /	Taken into account See other comments & responses on nuclear fusion regarding achievements and future

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						INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	technology development
4-706	A	35	19	35	28	It is necessary to add the sentences to explain the reality of fusion reactors. Example sentences are as follows. There is no fusion reactor in the world. Devices for fusion research have never created net electricity output yet. (Kenichi Oshima, Ritsumeikan University)	Taken into account One could add that scientific feasibility has been proven, but technical feasibility remains to be demonstrated in experimental facilities, such as ITER.
4-707	A	35	20	35	20	It would be useful to define long-term. In this case it means sometime after 2050, but without definition, each reader is left to guess at the timeframe. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Noted See response to next comment
4-708	A	35	23		28	line 23-28: "it will be some time" is very vague. Most scientist agree that it will take at least 50 years to achieve commercial status for nuclear fusion – if ever. Given that "a long period of penetration into the market place will be needed" [line 24-25] and that the planning horizon for new nuclear power stations is some 15 years or longer, it would be 65 years before the first reactor is there and at least another 25 years for penetration. "It will be some time" [line 27] is too vague. Line 27 should state a concrete figure, e.g. "….. it would take app. 100 years before fusion could become a dominant power supply". (Arjette Stevens, De Koepel)	Taken into account The text will be revised to more quantitative in suggested points.
4-709	A	35	27	35	28	The end of the sentence is too unspecific. Who says this? Is it the IPCC's assessment? What is 'some time'? (Kenneth Möllersten, Swedish Energy Agency)	Accepted See above response to above comment.
4-710	A	35	31	38		4.3.3 Renewable Energy section is given too much pages compared to other sections in the chapter. (Koji Kadono, Global Industrial and Social Progress Research Institute)	Ralph: Overall pages are going to be cut. Worry about this comment later.
4-711	A	35	33	35	35	COMMENT: REN21(2005) adopts 17% as a share of hydropower using a different efficiency to that of IEA. IEA applies 100% as an efficiency for hydropower. "Wind at <0.7%" is not incorrect but IEA provides 0.4%. REFERENCES: REN21 Global Status Report 2005; IEA, Renewables Information 2005 (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Eric: Report both numbers, say why there is a difference in the analysis method. This could be done in a footnote.
4-712	A	35	33	35	35	COMMENT: REN21(2005) adopts 17% as a share of hydropower using a different efficiency to that of IEA. IEA applies 100% as an efficiency for hydropower. "Wind at <0.7%" is not incorrect but IEA provides 0.4%. REFERENCES: REN21 Global Status Report 2005; IEA, Renewables Information 2005	See 711

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						(MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	
4-713	A	35	37	35	40	Support for strengthening this statement can be found in IEA's World Energy Outlook 2004 (Pg. 430), which projects a decline in renewables share of the primary energy supply from 21% in 2002 to 19% in 2030. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Eric: Quote WEO 2005. The decline of relative share of mature technologies will be contrasted with increase in relative share of modern technologies.
4-714	A	35	40	35	43	RECOMMENDATION: Modify text to read "In OECD countries for example, renewable energy sources fuelled 24% of electricity generation in 1970 but this had fallen to only 15% by 2001 as electricity demand had risen and growth in renewable generation had not matched the growth in fossil fuel and nuclear supply (IEA, 2004)." JUSTIFICATION: The existing text gives the misleading impression that the reduction renewable supply, in percentage terms, is a consequence of the use of fossil fuels and nuclear generation. The proposed text notes the role of growth in electricity demand for the change in percentage share of renewables generation and clarifies that the use of fossil fuels or nuclear is not to blame for this reduction. (Jonathan Cobb, World Nuclear Association)	Eric: will reword to also mention increasing electricity demand.
4-715	A	35	42	35	45	Point of the sentence is fine, but it is unusually awkward. (Stan Bull, National Renewable Energy Laboratory)	Eric improve sentence
4-716	A	35	45	35	45	It is proposed to add "for renewable energy" in order to improve clarity. (Radunsky Klaus, Umweltbundesamt)	Eric OK
4-717	A	35	47	36	5	This is loosely connected to a compilation of the current scientific knowledge concerning renewable energy. (Kenneth Möllersten, Swedish Energy Agency)	Noted
4-718	A	35	0			Section 4.3.2 additional ref's on nuclear energy: Two possible references on sustainability of nuclear: Van der Zwaan, B.C.C. Nuclear power and global climate change: security concerns of Asian developing countries, in: Resources, Energy and Development, 1, 2004, pp.1-18. Van der Zwaan, B.C.C., Rothwell, G. Are light water reactor systems sustainable?, in: The Journal of Energy of Energy and Development, volume 29, no. 1, 2003. Abstracts: The problem of global climate change will be solved by meeting stringent, long-term policy targets that are much more ambitious than the short-term, greenhouse gas emission reductions that some countries currently attempt to reach. The large-scale implementation of carbon-free technologies constitutes one of the measures essential to realize the mitigation of global warming. Nuclear power generation involves no carbon dioxide emissions, but the current use of nuclear energy cannot	Noted The mentioned aspects are already described in the section. Further discussion will appear based on several review comments.

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						be considered sustainable. However, in attempting to achieve sustainable development - and to establish transition paths towards sustainable energy systems in particular - nuclear energy might, for the moment, need to remain a component of the global energy mix. Van der Zwaan, B.C.C., Rothwell, G. Are light water reactor systems sustainable?, in: The Journal of Energy of Energy and Development, volume 29, no. 1, 2003. Abstract: This paper discusses the concept "intermediate sustainability," in which there is some substitution between natural and technical capital over the foreseeable future. We suggest criteria by which to judge the intermediate sustainability of nuclear energy, in particular the LWR energy system. We conclude that LWR technology does not violate intermediate sustainability criteria for environmental emissions (including LWR plant health and safety) or accidental radioactive release. However, one could argue that LWR energy systems do not satisfy all of the intermediate sustainability criteria because of (1) their use of a depletable resource, uranium, and (2) the existence of externalities associated with the proliferation of nuclear weapons. Also, we conclude that the LWR industry is not economically sustainable unless the cost of new LWR capacity is greatly reduced. Therefore, we suggest new nuclear power research to focus on proliferation-resistant technologies with (1) lower costs of construction and (2) increased fuel efficiency in the longer run. (Ad Seebregts, Energy research Centre of the Netherlands)	
4-719	A	35	0	47		Renewable Energy p35 Overall impression is, that authors don´t really believe in renewable technologies, and the technical description indicates, that the knowledge about those systems seems to be very limited. While the future technical developments and possibilities of conventional technologies have been outlined in great detail, this is missing in the RE chapter. The chapters about conventional technologies (fossils, nuclear) are not balanced compared to the RE chapter! Most of the market data from concentrated solar thermal, Solar PV and Wind energy are pretty old, below the links to the latest information: http://www.greenpeace.org/international/press/reports/Concentrated-Solar-Thermal-Power	Ralph: Will add literature sources and update data.

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						http://www.greenpeace.org/international/press/reports/windforce-12-2005 http://www.greenpeace.org/international/press/reports/solar-generation-ii I´m missing other scenarios like WBGU 2003 (= IPCC members), from the German Advisory Council: http://www.wbgu.de/wbgu_jg2003_kurz_engl.pdf and a reference of the contribution of RE in meeting the EU kyoto target. See e.g. : J.Waller Hunter, executive Secretary of the UNFCC: the contribution of renewable energy in meetin the climate challenge. Key note address of the international conference Bonn Renewables 1-4/6/04 (Arjette Stevens, De Koepel)	
4-720	A	36	6			Neither solar water heating nor on-shore wind can be claimed as mature with high market penetration except in a very few countries. In the next category, there are countries where market penetration is quite high for four of the renewable energy forms cited. (Michael Jefferson, World Renewable Energy Network/Congresses)	Ralph: “mature with substantial market penetration in some regions or countries”
4-721	A	36	7	36	8	"mature with high market penetration" is correct only for large hydro and hot-water-based geothermal, and only in the sense of high market penetration in their local markets, not worldwide. The others in the first group -- woody biomass combustion, enhanced geothermal, landfill gas, solar water heating, and on-shore wind -- should be classified as "commercially developed with relatively low market penetration." (Stan Bull, National Renewable Energy Laboratory)	See 720
4-722	A	36	9	36	16	Text is confusing when compared to lines 24-25. The term "commercially developed" as used in here does not imply competitiveness or ability to do without government support (as one might conclude from lines 24-25). This should be worded much more precise to be useful. Personally I find the term "commercially developed" not appropriate at all, since there is a gradual scale. For instance for PV, one sees thin-films on the market in parallel to crystalline silicon. The same is true for some other options listed. Note also that "thin-film PV" includes organic and dye technologies. One may say: "organic and inorganic thin-film technologies, including nano-structured devices". (Wim Sinke, Energy research Centre of the Netherlands)	Ralph “commercially available” but relatively … Eric will rewrite all of lines 6 – 16.
4-723	A	36	9	36	10	Market penetration of PV is very low (Kenneth Möllersten, Swedish Energy Agency)	Noted
4-724	A	36	9	36	16	Text is confusing when compared to lines 24-25. The term "commercially	See 722

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						developed" as used in here does not imply competitiveness or ability to do without government support (as one might conclude from lines 24-25). This should be worded much more precise to be useful. Personally I find the term "commercially developed" not appropriate at all, since there is a gradual scale. For instance for PV, one sees thin-films on the market in parallel to crystalline silicon. The same is true for some other options listed. Note also that "thin-film PV" includes organic and dye technologies. One may say: "organic and inorganic thin-film technologies, including nano-structured devices". (Wim Sinke, Energy research Centre of the Netherlands)	
4-725	A	36	9	36	16	Text is confusing when compared to lines 24-25. The term "commercially developed" as used in here does not imply competitiveness or ability to do without government support (as one might conclude from lines 24-25). This should be worded much more precise to be useful. Personally I find the term "commercially developed" not appropriate at all, since there is a gradual scale. For instance for PV, one sees thin-films on the market in parallel to crystalline silicon. The same is true for some other options listed. Note also that "thin-film PV" includes organic and dye technologies. One may say: "organic and inorganic thin-film technologies, including nano-structured devices". (Ad Seebregts, Energy research Centre of the Netherlands)	See 722
4-726	A	36	9			insert "with" after "but" (Danny Harvey, University of Toronto)	Ok eric
4-727	A	36	9	36	12	"commercially developed but relatively low market penetration" should include the items mentioned in the comment above, as well as crystalline silicon PV, amorphous silicon PV, municipal solid waste-to-energy, bioethanol from sugars and starch, cofiring of biomass, small and mini-hydro. (Stan Bull, National Renewable Energy Laboratory)	See above. Eric
4-728	A	36	10	36	10	Given the situation in Brazil, the US, Canada and other countries, I would argue that bio-ethanol belongs in the first category, but it depends on what you mean by 'relatively low market penetration'. (Steve Sawyer, Greenpeace International)	See above. Eric
4-729	A	36	13	36	13	thin film PV is - at least in Germany - commercially attractive and is continuously gaining market shares; thus, thin film PV may have to be classified in group 2 (commercially developed butlow market share) rather than group 3 (under development). (Joachim Schleich, Fraunhofer Institute Systems and Innovation Research)	See above. Eric
4-730	A	36	13	36	16	"under development and possibly near to market" should include anaerobic	See above Eric.

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						digestion, biodiesel, concentrated solar dishes and troughs, offshore wind, some fuel cell technologies, and dye-based solar cells. (Stan Bull, National Renewable Energy Laboratory)	
4-731	A	36	14	36	15	Why is wave energy repeated? (Kenneth Möllersten, Swedish Energy Agency)	See above Eric
4-732	A	36	16			You need an additional category of "under development" for thin-film PV, multi-junction / high-efficiency PV, concentrating PV, biomass gasification and pyrolysis to syngas and hydrogen, bioethanol from ligno-cellose, biorefineries, genetically modified energy crops, solar thermal towers, and fuel cell technologies in general. (Stan Bull, National Renewable Energy Laboratory)	See above eric
4-733	A	36	16			You need an additional category of "in basic research stages" for organic and inorganic nano-solar cells, quantum-dot solar cells, designer plants for energy and multi-uses, artificial photosynthesis, ocean energy of all types, hydrogen production from direct sunlight and water, hydrogen production from algae and water, lightweight hydrogen storage technologies, and advanced fuel cell technologies. (Stan Bull, National Renewable Energy Laboratory)	See above eric.
4-734	A	36	17	36	17	A fourth bullet on long-term renewable energy technologies has not been provided. There are certainly ideas in this category such as genetically modified organisms for biomass. (Robert Goldston, Princeton Plasma Physics Laboratory)	Eric. Accept.
4-735	A	36	18	36	19	Bold statement. Please support this with good data and references because many people (like me) do not inmediatly see that mature renewable energy (except large hydro) "have mostly been left to compete in todays energy markets without policy support". (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Eric. Qualify.
4-736	A	36	18	36	25	The general idea of this paragraph is fine, but there are many inaccuracies in the individual technologies cited. (Stan Bull, National Renewable Energy Laboratory)	See 735. Qualify.
4-737	A	36	18	36	22	Not all solid wastes are characterised as 'biomass' (and consequently landfill gas generated by their disposal). (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Same differentiation as IPCC: biomass-components are cO2 neutral and thus renewable, others not. We could cross-reference to chapter 10 “Waste”.
4-738	A	36	19			biomass still needs policy support (e.g. in the Netherlands) (Ad Seebregts, Energy research Centre of the Netherlands)	See 735. Qualify.
4-739	A	36	20		21	I doubt if wind farms and bioduels can compete right now (without subsidies), even	See 735. Qualify.

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						in the best locations (Ad Seebregts, Energy research Centre of the Netherlands)	
4-740	A	36	22			Deployment can also be slow partly because of genuine concerns about visual impacts, impacts on natural habitats, etc (e.g ill-placed wind energy developments, large-scale biomass/biofuel schemes/tidal barrages). The wording in the draft is too judgemental in favour of renewable energy developments without due regard to potential drawbacks in some instances. (Michael Jefferson, World Renewable Energy Network/Congresses)	These things should be discussed under the invididual technologies. Here would be the wrong place.
4-741	A	36	31	36	34	It should be added that the European Union has introduced relevant legislation (Directive 2001/77/EC), which sets a mandatory target for the penetration of renewables in electricity generation (i.e. the share of renewables to total gross electricity production must reach 22% in 2010) on Community level and further establishes indicative targets per Member State in order to achieve the overall EU target. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Ralph. This should be in the policy section, check that it is there.
4-742	A	36	32	36	34	That number is now 43, see Martinot 2005 p. 19 (Steve Sawyer, Greenpeace International)	Ralph: Accept, Update
4-743	A	36	32	36	32	COMMENT: It is not clear why Mali is taken as one of the examples. Is it meant to enphasize that small African countries such as Mali have policies to enhance the deployment of renewable energy? (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Ralph The countries listed are 13 developing countries. There are no other developing ones. So this should be updated.
4-744	A	36	32	36	32	It is not clear why Mali is taken as one of the examples. Is it meant to enphasize that small African countries such as Mali have policies to enhance the deployment of renewable energy? (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	See 744
4-745	A	36	32	36	33	Include the EU (Gabriela Von Goerne, Greenpeace)	No, because developing, see 743.
4-746	A	36	37	36	39	Sentence is confusing. (Stan Bull, National Renewable Energy Laboratory)	Reword. Ralph.
4-747	A	36	37	36	37	It is proposed to add "e.g." after "for which" because there are also other countries like Austria that introduced mandatory blending of petroleum fuels with biofuels. (Radunsky Klaus, Umweltbundesamt)	See 744.
4-748	A	36	40	36	50	Perhaps it makes sense to include a section on energy storage technologies and prospects, given the intermitency of renewable energy and the fact that you	This point has come up several times. Will be addressed – need to expand intermittency and

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						highlight this in Figure 4.3.11. One resource: http://www.eere.energy.gov/EE/power_energy_storage.html (Lee Lynd, Dartmouth College)	energy storage discussion. (Ralph)
4-749	A	36	40	36		As for renewables, the European perspective, and the role of policy in the EU could be emphasizes stronger. For example, analyzing the performance of renewables in the EU 25, Ragwitz et al (2005) find in a study for the European Commission that the European renewables energy market has altered considerably and undergone severe changes over the last decade. The increased deployment of renewable energy sources was triggered by EU policies, such as (1) the White Paper "Energy for the Future" (European Commission 1997, Energy for the Future: renewable sources of energy, White Paper for a Community Strategy and Action Plan, COM (1997) 599 final (26/11/1997)), which set a target of doubling the share or renewable energy in primary energy consumption from 6% in 1997 to 12 % in 2010, (2) the Green paper on the security of energy supply in Europe (European Commission, 29 November 2000 (COM (2000) 769 final)). (3) the Directive on the promotion of renewable electricity on the international market (EC (2001) Directive 2001/77/EC of The European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market) which aims at reaching a 21% share of renewable electricity by the year 2010 for the EU 25 and specifies indicative targets for all 25 Member States, (4) The Directive on the energy performance of buildings (Directive proposal on the energy performance of buildings COM (2001) 226 final, supporting, among others, the application or renewables for heating purposes, (5) The Directive on the promotion of biofuels (Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels and other renewable fuels for transport, which aims to increase the use of biofuels in the internal market from the current 0.6% to 2% of total consumption of transport fuels in 2005 and to 5.75% in 2020, and (6) The Council Directive on restructuring the Community framework for the taxation of energy products and electricity (Directive 2003/96(EC of 27 October 2003). Ragwitz et al (2005) also analyze the possible contribution of renewable energy sources to EU energy consumption in 2020, using a business-as-usual-scenario (with existing and planned policies) and a policy scenario (most effective policy for each technology in place, barriers will be overcome). In the BAU scenario, renewable energy sources will reach a share of 23% in electricity generation and of 11% in primary energy use. In the policy scenario, the share in electricity generation will be 32%,	Agreed. Should mention EU activities. Detaile discussion of directives however should be in policies and instruments section. Ralph.

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						and about 20% in primary energy use. 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)	
4-750	A	36	41	36	45	A paragraph that describes what is meant by renewable energy sources should be included as the first paragraph in section 4.3.3. The description offered here is not as good as the description offered in the earlier, overview portion of Chapter 4. Also, the benefits (ubiquitous etc) should be described in one place, such as the paragraph on page 35 line 47. (Stan Bull, National Renewable Energy Laboratory)	Shift para to the beginning and merge with text there. Ralph.
4-751	A	36	43		45	Energy storage is only one of many ways to address variable output from renewables – and other production technologies!, e.g. improvement and expansion of interconnectors, full legal and ownership unbundling of transmission and generation activities, geographical spread, improved short-term forecasting, reduce gate-closure times, more effective balancing and settlement procedures, more actively managed distribution grids, R&D, improved cross-border transmission for renewable electricity. Furthermore, the above techniques are only necessary for very large shares of wind energy in the system, app. 20% or more. If other renewables are included that figure will be higher before serious practical or technical measures have to be applied. The established control methods and existing backup capacity in the systems are sufficient to deal with 20% wind as seen in certain areas of Spain, Germany and Denmark. (see above references) (Arjette Stevens, De Koepel)	See discussion on intermittency. Will be expanded.
4-752	A	36	43			"They are however intermittent over various time frames" should be changed to "They are however variable over various time frames".Justification:Wind and other renewals are variable in output. The term "intermittent" is misleading. When a fossil or nuclear trips off the system unexpectedly it happens instantly, resulting in up to a thousand MW of capacity going off line at once. That is intermittency! Power systems are designed to deal with such situations. By contrast, wind power does not suddenly trip off the system because there are hundreds or thousands of units on the system. The system will not notice a 3 MW wind turbine coming off line, but it has to respond to a 500 MW coal plant or 1,000 MW nuclear plant. Variability does have an impact on system operation but variable production is no more complicated to deal with than variable demand and it can to a large degree be predicted. Therefore, throughout the text, "intermittency" should be replaced by	Taken into account The special importance of large power plant units will be mentioned. See 751

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						"variability" when referring to variable output renewables. See more on this issue in "Large scale integration of wind power", EWEA, December 2005: Exec summary: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/grid/051215_Grid_report_summary.pdf Main report: http://www.ewea.org/fileadmin/ewea_documents/documents/press_releases/2005/051215_Grids.pdf (Arjette Stevens, De Koepel)	
4-753	A	36	43	36	45	Unfortunately, the authors are largely silent on the importance of storage as a constraint on large scale solar (and wind too), other than saying on page 36 (at line 43-45) that "…energy storage technologies may [the word should be 'will" not "may"] be needed, particularly for wind and solar, though stored hydro reserves, geothermal and biomass can all be used as back-up sources". But how much (and how reliable) a back-up can these potential "back-ups" actually provide? (Storage via electrolytic hydrogen may be sharply limited because not only is it expensive, but arguably more important, because it requires very large amounts of fresh water (using salt water would release large amounts of chlorine to the atmosphere) of distilled water quality (to prevent fouling the electrolyzers), a resource that is not likely to be available in sufficient quantities in many (particularly desert and desert-like) areas of high insolation.) (Christopher Green, McGill University)	See 751
4-754	A	36	43	36	45	The issue of intermittency for wind and solar technologies is mentioned here, but the discussion is woefully inadequate. Improvements in cost and performance for electricity storage technologies are critical to the broad adoption of renewable electricity technologies. The comment about stored hydro reserves, geothermal, and biomass fuels being used as back-up sources makes little sense in this context. (Stan Bull, National Renewable Energy Laboratory)	See 751
4-755	A	36	47	36	49	This figure (4.3.11) is unclear and incorrect. Moreover, the concept "variability/intermittency" is used in an outdated manner. The word "intermittent" is not used correctly (NB!). Technologies may be intermittent or variable over time, not intermittent over various time frames. For wind and solar, one may state that they are not variable on a yearly basis (typically only+/- 10%), hence the figure is not correct here. In addition, as an ensemble (averaged over larger numbers of installations as applied in practice), they are much less or even not variable on a minutes basis. Finally, they may be variable, but are nevertheless predictable to a large extent on the shorter timescales.	See 751

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Wim Sinke, Energy research Centre of the Netherlands)	
4-756	A	36	47	36	49	This figure (4.3.11) is unclear and incorrect. Moreover, the concept "variability/intermittency" is used in an outdated manner. The word "intermittent" is not used correctly (NB!). Technologies may be intermittent or variable over time, not intermittent over various time frames. For wind and solar, one may state that they are not variable on a yearly basis (typically only+/- 10%), hence the figure is not correct here. In addition, as an ensemble (averaged over larger numbers of installations as applied in practice), they are much less or even not variable on a minutes basis. Finally, they may be variable, but are nevertheless predictable to a large extent on the shorter timescales. (Wim Sinke, Energy research Centre of the Netherlands)	See 751
4-757	A	36	47	36	49	This figure (4.3.11) is unclear and incorrect. Moreover, the concept "variability/intermittency" is used in an outdated manner. The word "intermittent" is not used correctly (NB!). Technologies may be intermittent or variable over time, not intermittent over various time frames. For wind and solar, one may state that they are not variable on a yearly basis (typically only+/- 10%), hence the figure is not correct here. In addition, as an ensemble (averaged over larger numbers of installations as applied in practice), they are much less or even not variable on a minutes basis. Finally, they may be variable, but are nevertheless predictable to a large extent on the shorter timescales. (Ad Seebregts, Energy research Centre of the Netherlands)	See 751
4-758	A	36	0			Section 4.3.3 comment -- the advantages and challenges of the distributed nature of renewables should be covered in a paragraph somewhere near the beginning of section 4.3.3, and cross-referenced to section 4.4.x. Briefly, distributed power production increases the reliability of electricity, especially if local storage is available, by providing multiple energy sources. However, interconnecting distributed power generating systems with the electrical systems of a building or community or the local grid is a challenge that is only beginning to be examined and addressed. (Stan Bull, National Renewable Energy Laboratory)	See 751. There needs to be a substantial rewrite and incorporation of these comments. Should use literature: Gul and Stenzel, 2005 – Ralph has a copy. Ralph will write draft and ask Stan Bull or Bryan Wiser at LBL for comments. (Bryan: Eric will provide e-mail address)
4-759	A	37	12	37	16	The CDM should be mentioned in this context. (Kenneth Möllersten, Swedish Energy Agency)	Should be mentioend in policies and instruments, otherwise would need to mention it everywhere.
4-760	A	37	34	37	34	I suggest adding an explanation for the emissions in hydro reservoirs "… Gross carbon dioxide and methane emissions due to decay of the biomass were measured …"	See 2006 IPCC Guidelines discussion. Bernhard to contribute this after April IPCC Plenary.

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						(Torsten Clemens, OMV E&P)	Anne Jakle – Ralph will contact.
4-761	A	37	38	37	39	It is proposed to differentiate between tropical countries and other countries in temperate and other zones with colder climatic conditions because such high GHG emissions may only occur in tropical countries under specific conditions (flooding of forested area). (Radunsky Klaus, Umweltbundesamt)	Accept Anne
4-762	A	38	0			The text only states the wind power technology in terms of "resources". As with other energy technologies, a "sustainability issues" subsection should be added that mentions various problems the technology could cause such as scenary, location and risks on eco-system. (Shinichi Nakakuki, Tokyo Electric Power Company)	Agreed. Ralph will do all Wind comments. Eric will do all solar heating and solar pV comments. All suggested reactions to comments on wind energy are from Bernhard. Not yet checked by Ralph or Eric. But it seemed straightforward mostly.
4-763	A	38	4		6	4.3.3.2 WIND "The global wind energy resource is several times higher than the current total global electricity demand. However, only a little over 0.5 EJ/year of wind energy was captured in 2003 (World Energy Council, 2004).", should be changed to:"The global wind energy resource is several times higher than the current total global electricity demand. The installed wind power capacity by end 2004 generates energy equal to 0.6% of global 2002 electricity production." (See reference below – line 6-7). The calculation seems based on the 39 GW capacity producing 67 TWh in 2003 quoted in line 7. That implies a capacity factor of 19.6% which is ridiculously low. Using the average European capacity factor in 2004 for all turbines (including the old inefficient turbines installed up to 20 years ago) of 23%, 39 GW would produce 79 TWh. (Arjette Stevens, De Koepel)	Seems reasonable. Ralph.
4-764	A	38	4	38	5	How do you define the "global wind energy resource"? The total kinetic energy of the atmosphere? Earth surface entirely covered by wind turbines? There is no way to define this value without a convention, so the convention should be mentioned. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	What about a different terminology, such as global potential for electricity generation from wind? May alos need to revise the numbers then.
4-765	A	38	6		7	"Wind power has increased from an installed capacity of 2.3 GW in 1991 to 39 GW at the end of 2003 generating 67 TWh in that year." , should be changed to:"Wind power has increased from an installed capacity of 2.3 GW in 1991 to 47 GW at the end of 2004 which generate 95 TWh annually." Reference:	See also 763. accept.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						http://www.gwec.net/fileadmin/documents/PressReleases/0304-GlobalWindEnergyMarkets-FINAL.pdf. 95 TWh equals 0.6% of global 2002 electricity production of 16,074 TWh (ref. IEA 2004) (Arjette Stevens, De Koepel)	
4-766	A	38	6	38	8	More recent data are available. GWEC (Global Wind Energy Council - global forum for the wind energy sector, see http://www.GWEC.net/) presents data for the end of 2004 in which the cumulative capacity is 47912 MW, with an average growth over the last five years of 28%. Also on the website of the International Energy Agency more recent figures can be found (http://www.ieawind.org) (de Lange Theo J. , Energy research Centre of the Netherlands)	Accept
4-767	A	38	6	38	8	More recent data are available. GWEC (Global Wind Energy Council - global forum for the wind energy sector, see http://www.GWEC.net/) presents data for the end of 2004 in which the cumulative capacity is 47912 MW, with an average growth over the last five years of 28%. Also on the website of the International Energy Agency more recent figures can be found (http://www.ieawind.org) (Ad Seebregts, Energy research Centre of the Netherlands)	Same as 766
4-768	A	38	6	38	7	COMMENT: The IEA's statistics officially covers up to 2003, but the data of 2004 have been widely known and it is 47.5GW. REFERENCE: Windpower Monthly "Windicator", World Wind Energy Association (WWEA) (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Might be addressed by 766
4-769	A	38	6	38	7	The IEA's statistics officially covers up to 2003, but the data of 2004 have been widely known and it is 47.5GW. REFERENCE: Windpower Monthly "Windicator", World Wind Energy Association (WWEA) (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Same as 768
4-770	A	38	6	38	8	Global wind capacity reached 48 GW at the end of 2004, and grew 28% per year between 2000-2004, according to REN21 Renewable Energy Policy Network. 2005. “Renewables 2005 Global Status Report.”Washington, DC:Worldwatch Institute. (Steve Clemmer, Union of Concerned Scientists)	Also related to the above. The 28% growth between 2000-2004 is worth mentioning but using the ref in 771.
4-771	A	38	8	38	8	growth rates in the wind industry are 28% for the past 5 years, see Martinot (2005) p. 8 (Steve Sawyer, Greenpeace International)	See 770

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-772	A	38	10	38	12	Sentence is confusing. I agree that offshore wind will grow rapidly, but you can't just assume public objections will reduce. Suggest adding a separate sentence explaining the problem with public objections about visual impacts and how they have to be diligently addressed and resolved to encourage offshore wind to grow rapidly. (Stan Bull, National Renewable Energy Laboratory)	Incorporate in general paragraph about non-GHG aspect s of wind, already asked for by other comments.
4-773	A	38	11			Delete "in some regions".Justification: There are no regions in the world where the offshore wind speeds are not higher offshore than onshore. (Arjette Stevens, De Koepel)	Agreed.
4-774	A	38	14	38	20	Apart from the EWEA target, there is the GWEC target of 1250 GW installed windpower capacity in 2020, which would supply 12% of the world's electricity supply in 2020. With an average growth rate of 25% (see page 38, line 8) this target could be realised. The largest part of this growth will not be in Europe. In that respect one could argue that at this moment wind energy cvan not be considered as a global market, but this will change defenitely in the coming decade. (de Lange Theo J. , Energy research Centre of the Netherlands)	Incoprorate the essence of this, adding on to the 28% recent growth mentioned in one of the earlier comments (770)
4-775	A	38	14	38	20	Apart from the EWEA target, there is the GWEC target of 1250 GW installed windpower capacity in 2020, which would supply 12% of the world's electricity supply in 2020. With an average growth rate of 25% (see page 38, line 8) this target could be realised. The largest part of this growth will not be in Europe. In that respect one could argue that at this moment wind energy cvan not be considered as a global market, but this will change defenitely in the coming decade. (Ad Seebregts, Energy research Centre of the Netherlands)	Same as 774
4-776	A	38	14	38	15	This sentence is technically correct but four out of the top ten global markets are outside Europe (Japan, China, US and India) and the largest growth rates in 2005 are likely to have been in the US - See Martinot 2005, and Global Wind Energy Council and Greenpeace, Wind Force 12 (2005) at http://www.gwec.net/index.php?id=8 (Steve Sawyer, Greenpeace International)	Qualify the statement about Europe, mention some of the other markets and the references suggested. See NREL slide 3 on wind energy. This demonstrates that Europe is indeed biggest market.
4-777	A	38	17	38	17	"..the USA have similar stretch targets" -- I am unaware of a US target for wind power, although individual states may have specific wind targets within their own renewable portfolio standards. Please doublecheck accuracy. (Stan Bull, National Renewable Energy Laboratory)	Check whether US has target. What is a stretch target?
4-778	A	38	21	38	24	The largest turbine is not "approaching 5 MW" but is 6 MW (Enercon E-112 turbine) (de Lange Theo J. , Energy research Centre of the Netherlands)	Accept

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-779	A	38	21	38	24	The largest turbine is not "approaching 5 MW" but is 6 MW (Enercon E-112 turbine) (Ad Seebregts, Energy research Centre of the Netherlands)	Same as 778
4-780	A	38	23			Replace “approaching” with “commercially available” Ref: http://www.repower.de/index.php?id=237&L=1 (Arjette Stevens, De Koepel)	Accept, see also 778.
4-781	A	38	26	38	28	It is noted that the learning rate experience indicated in this paragraph differs significantly from the figure given in figure 4.3.10 (15% cost reduction per doubling of installed capacity versus 20%). It is recommended to improve consistency or to provide some additional explanation. (Radunsky Klaus, Umweltbundesamt)	A very thorough reviewer from Austria. Clarify discrepancy.
4-782	A	38	27			What is the real meaning of a 15% cost reduction per doubling of installed capacity in Denmark since 1985? West Denmark, for example, has an installed wind energy capacity of 2.4 GW (the highest per capita figure in the World). However, most of this is exported through interconnectors to Sweden, Norway, and Germany.In 2003 only about 4% of Denmark's power consumption was provided by wind, most of the wind generated power being exported to maintain stability in the domestic grid. For the Danish consumer electricity prices have been running at double the UK level for some years, with the additional cost burden of wind energy variously estimated at Dkr 3.40-3.85 billion per annum (Bendtsen, 2003) to DKr 8-10 billion per annum (Krogsgaard, 2001). Or, as a former Chairman of Eltra (Kongstad) has put it: "The consequence of the many wind turbines and decentralised power stations is that during the winter there is regularly produced 1,000 to 2,000 MW more than is needed in our area. This over-production we must dispose of on the open market for considerably less than we have paid." Such exports have been estimated at some DKr 1 billion per annum (Sharman). FOD text as it stands gives a misleading (or at least very partial) impression. (Michael Jefferson, World Renewable Energy Network/Congresses)	This is about production cost, not consumer prices. Also, exports or imports are irrelevant in this context. One should indeed mention that there are extra requirements for power grid enhancements and other hidden costs. There is also talk about back-up fossil capacity, not sure how true this is. In any event, as this comment is specific to Denmark, Joergen should look it over
4-783	A	38	30			Fig. 4.3.12 has a bearing on the previous comments about wind energy, especially in relation to Denmark (from comment on page 38, line 27 of this chapter). Reference to wind power economics based on Danish experience should not simply offer a Euro/kWh comparison but include the realities for wind power's contribution to, and costs for, Danish electricity consumers (see, for example, the comment on Chapter 4, page 38, line 27). Also, in the example given here, two Roughness Indicators are given. How many readers will know what Roughness Indicators are? Why not offer a description of the full array from 0 (=open water -	Should also be addressed by Jorgen.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						surely of some interest for offshore developments and potential)through to at least 2.5, and possibly 3? It would also be useful to warn somewhere in the chapter or its appendix that developments should be in areas of at least high Class 3 (the US definition) wind speed regimes, preferably 4, and there are dangers of backlash on the industry and renewable energy. Renewable energy penetration more generally if government subsidies are encouraged into locations where wind speeds are in high Class 1/low Class 2 regimes (as is occurring). Even at 80 metres hub height these offer wind power of only around 200W per square metre. (Michael Jefferson, World Renewable Energy Network/Congresses)	
4-784	A	38	30			figure 4.3.12: What is the roughness class? (Marco Mazzotti, Institute of Process Engineering)	Good point; explain in 3-4 words.
4-785	A	38	32	38	35	Apart from the mentioned developments there are large developments in control strategies for individual turbines as well as for wind farms as a whole. Due to the larger turbine seizes more accurate aero-elastic models are being developed and more advanced control strategies are used to keep the loads within the design limits. Another development is the dedicated offshore turbine and the development of O&M-strategies for offshore farms (as they are not easy accessible for maintenance activeties due to bad weather / rough seas and high costs). (de Lange Theo J. , Energy research Centre of the Netherlands)	Could mention these points briefly.
4-786	A	38	32	38	35	Apart from the mentioned developments there are large developments in control strategies for individual turbines as well as for wind farms as a whole. Due to the larger turbine seizes more accurate aero-elastic models are being developed and more advanced control strategies are used to keep the loads within the design limits. Another development is the dedicated offshore turbine and the development of O&M-strategies for offshore farms (as they are not easy accessible for maintenance activeties due to bad weather / rough seas and high costs). (Ad Seebregts, Energy research Centre of the Netherlands)	Same as 785
4-787	A	38	36		37	"The trend is to replace older and smaller wind turbines by more efficient…"", should be replaced by: In Denmark, older and smaller wind turbines from the 1980s are beginning to be replaced be by more efficient……":Justification: I would not call it a general trend. (Arjette Stevens, De Koepel)	While it may not be a general trend, it is certainly a general possibility? So perhaps we could point to this possibiltiy, and mention Denmark as example.
4-788	A	38	36	38	17	The trend is to replace older and smaller wind turbines by LARGER, more efficient, etc. (Stan Bull, National Renewable Energy Laboratory)	Yes, see also 787.
4-789	A	38	36	38	37	Higher outputs are also due to bigger turbines, with taller towers and longer blades	I think larger implies all, see 788.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Steve Clemmer, Union of Concerned Scientists)	
4-790	A	38	39	38	45	The wind has stochastic characteristics indeed, but can be predicted quite well (and increasingly more accurate). The statement that 20% windpower can be integrated without storage is a confusing one. In TECHNICAL sense a far higher percentage is possible when a proper REGULATORY framework is in place. Storage should not be related to windpower, but should be considerd on systemlevel, including all technical, regulatory and economic requisites / conditions under which the system should operate. The statement on integration with district heating and cooling, the possibility to overdimension the wind production capacity, heat pumps and so on, provides nice examples, but also very restricted ones: many other solutions / options are possible. Once again: do not confuse the discussion on wind energy by "drawing" possible subsystems, but argue that systemcharacteristics and the requisites / conditions for the system are determining the "most practical" percentage of windpower in the system. (de Lange Theo J. , Energy research Centre of the Netherlands)	I think this comment should be taken seriously. The example is indeed only one. Other examples include pumping water in montaneous countries, experiments are also under way to produce hydrogen as fuel, etc. And the 20% number should probably be assessed by someone like Joergen, who is familiar with this.
4-791	A	38	39	38	45	The wind has stochastic characteristics indeed, but can be predicted quite well (and increasingly more accurate). The statement that 20% windpower can be integrated without storage is a confusing one. In TECHNICAL sense a far higher percentage is possible when a proper REGULATORY framework is in place. Storage should not be related to windpower, but should be considerd on systemlevel, including all technical, regulatory and economic requisites / conditions under which the system should operate. The statement on integration with district heating and cooling, the possibility to overdimension the wind production capacity, heat pumps and so on, provides nice examples, but also very restricted ones: many other solutions / options are possible. Once again: do not confuse the discussion on wind energy by "drawing" possible subsystems, but argue that systemcharacteristics and the requisites / conditions for the system are determining the "most practical" percentage of windpower in the system. (Ad Seebregts, Energy research Centre of the Netherlands)	See 790, same.
4-792	A	38	39	38	45	Wind energy accounted for 21% of Denmark's electricity in 2004, and up to 25% in West Denmark, with it's own grid, these percentages can easily go higher, particularly where there is large hydro capacity to act as a storage system…and pumped storage, compressed air and modern batteries are other storage alternatives, see EWEA, 2005 “LARGE SCALE INTEGRATION OF WIND ENERGY IN THE EUROPEAN POWER SUPPLY: analysis, issues and recommendations” Exec. summary p. 10,	Jorgen should look this over (Denmark)

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						(http://www.ewea.org/fileadmin/ewea_documents/documents/publications/grid/051215_Grid_report_summary.pdf) and Mazza, P, and Hammerschlag, R, "Carrying the Energy Future: Comparing Hydrogen and Electricity for Transmission, Storage and Transportation", Institute for Lifecycle Environmental Assessment PO Box 22437 Seattle, Washington 98122-0437 www.ilea.org (Steve Sawyer, Greenpeace International)	
4-793	A	38	39	38	40	Perhaps. But there are also authors who name a higher limit (30% and more). It depends on the type of the backup power-units (gas CCGT allow a considerable higher wind quota than conventional power plants). The limiting value can be increased also by consumer technologies which permit supply interruptions (e.g. for cooling applications). (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	See also comment 791.
4-794	A	38	39	38	40	This sentence is not appropriate and, therefore, should be revised. Firstly, there is no evidence that supplying more than 20% of total electricity demand with wind energy is not practicable. Secondly, storage is not the only option to cope with the fluctuation and unpredictability of output from wind power. There are many measures other than storage such as weather forecast, power plants providing operational and capacity reserve, interconnection with other grid system, distributed generation, demand-side response, and curtailment of intermittent technology. See Gul & Stenzel (2005), Variability of Wind Power and other Renewables: Management Options and Strategies, IEA/OECD. (Kenichi Oshima, Ritsumeikan University)	See comment 791. needs addressing.
4-795	A	38	39	38	40	Primarily, there is no evidence that suplying more than 20% of total electricity demand with wind energy is not practicable. It is case by case issue. Secoundly, storage is not a only way to cope with the fluctuation and unpredictability of output from wind power. There are many measures other than storage such as weather forecast, power plants providing operational and capacity reserve, interconnection with other grid system, distributed generation, demand-side response, and curtailment of intermittent technology. It is necessary to refer to Gul & Stenzel, 2005, Valiability of Wind Power and other Renewables: Management Options and Strategies, IEA/OECD. (Masatake Uezono, Citizens' Alliance for saving the Atmosphere and the Earth)	See comments 791
4-796	A	38	39	38	40	It should be added however that there is research carried out on regional medium-	See 791.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						short term forecasting of electricity generated by wind through coupling weather forecasting tools and wind energy simulation tools. Better predictions of electricity generated by wind can reduce significantly the risk of loss-of-power and therefore allow for penetrations above 20%. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	
4-797	A	38	39	38	40	Storage is not necessarily needed at wind penetrations higher than 20%. In fact, regions in Germany, Denmark, and Spain are already exceeding 20% penetration without storage. Achieving penetrations higher than 20% will require additional ancillary service costs for integrating wind into the grid, including additional regulation and operating reserves. (Steve Clemmer, Union of Concerned Scientists)	See 791.
4-798	A	38	40			The discussion of wind energy suffers from many of the same sorts of problems that plague the discussion of solar photovoltaic energy. One of these is large scale storage, which is treated as if it somehow it will be available, if we need it. But storage is a very serious problem. It should be treated as seriously as is the storage of nuclear waste, the storage of captured carbon dioxide in CCS, and the storage of hydrogen. Moreover, the Report continues (p.38, line 40) to use 20% as the limit of total electricity demand met by wind energy without storage. This might possibly be true (although I doubt it) where there is full back-up by hydro, but few areas in the world have that luxury (an exception being Quebec where I live). In the absence of storage, I do not think that, with any confidence, more than 10% of electricity demand can be met direct delivery to the grid of intermittent energy sources, without seriously threatening to reduce system reliability-unless of course there is large scale spinning reserve. (Christopher Green, McGill University)	Noted Disposal/storage of nuclear waste has primarily safety objectives that are very much different than those related to “storage” of wind power Generic section by Eric on Storage issues.
4-799	A	38	46	43	29	The section 4.3.3.3 Biomass and bioenergy lacks structure. It could be more clear if it was rearranged in the order i) Sources (and potentials), ii) Technologies, iii) Overall performance and impacts. The subsection on overall performance and impacts is currently 25% on bioenergy with CCS and all of this is based on one highly speculative reference. (Kenneth Möllersten, Swedish Energy Agency)	Not a bad idea. Sources could be a summary of what is in the other chapters. This should include an overview table of the current numbers and potential numbers for 2020 and 2030 and 2050. Also the point about CCS is well taken and CCS should only be discussed in the general CCS section which was moved to after renewables.
4-800	A	38	46	40	40	Clear definition of biomass discussed in the chapter is needed ("biomass" could	Clear definition needed indeed, need to work

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						include plastics in the contect of municipal waste treatment.) (Shinichi Nakakuki, Tokyo Electric Power Company)	with glossary people. FAO was so far non-responsive on this, but should probably send our draft defs to them again. Plastic is no biomass. We talk about renewable MSW.
4-801	A	38	0	43		The discussion of biomass issues still lacks equilibrium. For example accepted technologies such as ethanol from lignocellulsoe are discussed on a par with obscure technologies such as glycerides from lignocellulose. Also traditional biomass and new biomass are often discussed so that they can easily be confused. They are quite different concepts though. IPCC should also be able to clearly indicate the benefits, drawbacks and especially the conditions to which biomass systems should comply in order to be of benefit to mitigating climate change. This last issue should be dealt with in more detail and also be included in the main summary. (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	Clear separation between traditional and modern biomass needed. See page 40 para, make this a separate subheading.
4-802	A	38	0	43		Generally the sections on Biomass should be checked for consistency (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	Obviously.
4-803	A	38	0	43		Generally biomass can be improved by checking consistent use of terms such as biomass, biofuels. Adding the term biotransportation fuel would improve redibility (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	See earlier comments on defs. Biotransportion fuel not in this chapter. We should only point to chapter 5.
4-804	A	38	0			Section 4.3.3.3 Comment -- (biomass) - I will also attach a file with our favorite graphics that you might consider in addition to, or instead of, some of the graphics you have for biomass. (Stan Bull, National Renewable Energy Laboratory)	We should consider these graphics, slides 10 and 12.
4-805	A	38	0			Section 4.3.3.2 Comment - (wind) -- The wind graphics seemed particularly sparse. I sense that this was written from a more European perspective, where wind has been so well established that it is almost not worth talking about in terms of future technical achievments. In the US the interest and growth of wind power plants is still in the very exciting stages, while in developing countries, opportunities are just beginning to be tapped. Some of that enthusiasm and a strong sense of possibility for the future should be reflected in the text of this section. I will also attach a file with our favorite graphics that you might consider, including wind shipment data, technical progress, etc. (Stan Bull, National Renewable Energy Laboratory)	Consider these graphics, especially 3 and 6. 3 also addresses an earlier comment about European role in wind energy.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-806	A	38	0			Sentence should read, "Bioenergy projects depend on securing a reliable and sustainable supply of biomass." As now written, the phrase "sustainable biomass" is unnecessarily ambiguous. (Reid Miner, NCASI)	Agreed.
4-807	A	39	1	39	3	Biochemicals and biomaterials are of much less importance in terms of renewable energy and especially GHG emissions as compared to bioenergy. We do not want this document to be an exercise in nest-feathering. The emphasis should be on energy per se. (Lee Lynd, Dartmouth College)	Agreed, but cascading is still important to maximize value. First use as material, then energy.
4-808	A	39	1	39	1	Should mention in the opening sentence that biomass continues to be the world's major source of food, feed, and fiber, and a significant source of electricity and heat through various types of combustion. Then explain that in addition to all that, biomass is recognized as having multiple future uses through advanced technologies, including liquid fuels from a variety of biomass sources, biomaterials, and biochemicals. (Stan Bull, National Renewable Energy Laboratory)	Agreed.
4-809	A	39	3			Add between " future. Belong" - Biomass is the only renewable resource of hydrocarbons for liquid fuels and chemicals and materials production. (Stan Bull, National Renewable Energy Laboratory)	Agreed.
4-810	A	39	4	39	4	It is proposed to insert "rural" before "economies". (Radunsky Klaus, Umweltbundesamt)	Agreed.
4-811	A	39	6	39	14	There may be some overstress on the downside problems associated with biomass here, but there are also risks associated with development of monocultures, adverse effects on natural habitats, insufficient attention paid to linking pathways between relatively undisturbed habitats, and adverse visual impacts and mess caused by large-scale harvesting. (Michael Jefferson, World Renewable Energy Network/Congresses)	Agreed.
4-812	A	39	6	39	15	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)	This is true for some technologies and not others. This para is not even about technologies. Somehow this comment must refer to somewhere else.
4-813	A	39	7	39	14	There is also the issue of competition for land resources and negative impacts on biological diversity in the case of inappropriately managed biomass production (this is an emerging conflict that needs to be mentioned, eg palm oil plantations that	See also 811. Accept.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						displace tropical forests.) (Kenneth Möllersten, Swedish Energy Agency)	
4-814	A	39	7	39	22	This description of biomass should precede the paragraph (page 39 line 7-14) passing judgment on the technology. (Stan Bull, National Renewable Energy Laboratory)	Agreed. This is the definition that needs to be upfront.
4-815	A	39	8			wordings 'dirty' and 'low' image other wording, although it refers to image (inherently subjectibe), try to avoid perceptions and subjectivism (Ad Seebregts, Energy research Centre of the Netherlands)	Use "….". "this results from its perception, by the public, as "dirty and low technology".
4-816	A	39	8	39	14	It is stated: "...results particularly from its dirty and low technology image, ...planning consents". Some readers may conclude that the word "particularly" applies to only "dirty and low technology image", while (at least I assume so) it applies to all of the mentioned difficulties. Therefore, I suggest that you instead write: "These are due to several aspects such as its dirty and ...planning consents". Also, could be good to mention here as difficulty that it has been difficult to convince the two potentially large future suppliers of feedstocks -forest companies and farmers- about the opportunities linked to bioenergy: that they tend to stick to core business and hesitate about e.g., investing in specialty equipment for the purpose of producing biomass feedstocks for energy. This also applies to conversion of biomass feedstocks to biofuels/electricity in forest industry: the additional income from producing biofuels in addition to, e.g., paper is not regarded high enough to motivate the investment in capital and risks of shut-downs due to problems with new technologies. (Göran Berndes, Chalmers University of Technology)	See 815. Rest of comment refers to ag and for chapters.
4-817	A	39	8	39	10	"its dirty and low technology image" -- boy, that isn't true in the US! Maybe for municipal solid waste, but not biomass wastes or energy crops. "high demand for water and nutrients by some energy crops" -- also not a legitimate concern; energy crops are no more demanding than modern food crops, and less than some. (Stan Bull, National Renewable Energy Laboratory)	See 815. say "sometimes".
4-818	A	39	10	39	11	I would prefer the use of the word biomass crop as it's use is not limited to energy but also includes chemicals and materials. (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	Agreed.
4-819	A	39	13	39	14	The remark implies a negative effect which is not always true. The impact of climate change on Biomass production can be both negative and positive: Higher CO2 content and longer growing season is positive - more drought is negative.	Agreed.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	
4-820	A	39	17	39	17	"specialist energy crop": I have not seen the word "specialist" in this context earlier. What crops are refered to? Is "specialist" used here to signal a distinction from food crops used for energy (cereals, sugar beet, rape seed, etc)? If you refer to crops such as Miscanthus, Switchgrass, Reed canary grass etc, maybe it's better to replace "...short rotation forest plantations, specialist energy crops.." with"...dedicated energy crops such as specific herbaceous crops and short rotation forests...". + include a few examples of specific energy crops to clarify. Later (on page 42) you mention that the primary feedstock for ethanol production remains sugar or starch from agricultural crops. In my view, they are then also energy crops and could well be mentioned already here as such. For your amusement (?): the Swedish Farmers Association LRF refer to cereals as "Natures own pellets" (Swedish farmers burn substantial volumes of cereal grain for heat). (Göran Berndes, Chalmers University of Technology)	Avoid word “specialist”. Use “biomass crops”.
4-821	A	39	25			Should summarize the infor from these chapters here so reader won't have to add them up. (Stan Bull, National Renewable Energy Laboratory)	Yes, an overview table with numbers, as suggested above.
4-822	A	39	29	39	33	Global biomass use is uncertain and this could be acknowledged by replacing "around 46 EJ" with "roughly 50 EJ", replacing "13.4%" with "10-20%", and replacing "...mainly from "traditional biomass" in the form of 32 EJ in 2002 of...in developing countries" with "...mainly (perhaps 60-70% of total biomass use) in the form of firewood, charcoal and dung which is used for traditional purposes (e.g., cooking, heating and brick making) in developing countries". Compare for instance the UNDP WEA numers for 1998: traditional biomass=38+/-10 EJ. Modern biomass = 7 EJ. (Göran Berndes, Chalmers University of Technology)	But we are quoting for a reference. But we could indeed also quote the WEA numbers.
4-823	A	39	31	39	31	replase "13.4%" to "10.6%" REFERENCE: IEA, Renewables Information 2005 (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	This should alsob e considered.
4-824	A	39	31	39	31	replase "13.4%" to "10.6%" REFERENCE: IEA, Renewables Information 2005 (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	See 823.
4-825	A	39	41	40	12	Regarding Figure 4.3.14, and line 12 on page 40 ("the energy imput/output ratios can be marginal"), much higher efficiencies have been projected for mature technologies. The Role of Biomass in America's Energy Future project, for	Chnge sentence on page 40. Add ref.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						example, has evaluated scenarios that achieve close to 80% efficiency (energy out/energy in, feedstock LHV basis). Though this work has yet to be published in full, preliminary results were made available in the NRDC's "Growing Energy" report: http://www.nrdc.org/air/energy/biofuels/contents.asp (Lee Lynd, Dartmouth College)	
4-826	A	39	45	39	45	It would be valuable if a reference to the information re 6EJ were provided. (Kenneth Möllersten, Swedish Energy Agency)	Agreed. Thisnumber should also be in overview table.
4-827	A	39	47	39	49	This provides that all the biomass energy derives from sustainably harvested biomass. Is this a fact? (Kenneth Möllersten, Swedish Energy Agency)	Put in a qualifyer that not all bioamss may be sustainable.
4-828	A	39	47	39	47	It would be valuable if a reference to the information re 3EJ could be provided. It is unclear whether the 3 EJ are what is actually collected currently or if it's some kind of technical potential. (Kenneth Möllersten, Swedish Energy Agency)	Agreed.
4-829	A	39	47	39	49	This statement needs some qualification. In how far has the fact been taken into account that much biomass originates from soures that are not replenished. For exaple charcoal in Africa which originates from foreste that are not replanted. (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	See 826
4-830	A	39	47	39	49	It is stated that: "if the 46 EJ of total energy from biomass were to be provided by a mix of fossil fuels at around 75 tCO2/TJ and 20-40% efficiency instead, atmospheric carbon emissions would be greater by about 0.5-1 Gt/yr". I can imagine that at least some readers would conclude from the mention of 20-40% efficiency that the 46 EJ to be provided is not primary energy but secondary energy carriers (kerosene, electricity, ...). Thus the reasoning would become: "ok, providing 46 EJ using a fossil fuel mix at 20-40% efficiency and with an average 75 tCO2/TJ leads to: (46*75) divided by 0.2 or 0.4 = 2.3-4.7 GtC". Maybe the risk of missunderstanding is less if you instead state: "if fossil fuels with an average carbon intensity at 75 tCO2/TJ were used to provide the energy services presently provided by using 50 EJ of biomass (primary energy), about 1 GtC would be released to the atmosphere (assuming the same efficiency as for biomass)". Then, if you think it is neccesary, you could mention that since much of the biomass is used very inefficiently, replacing the biomass with fossils would likely lead to higher average conversion efficiency and consequently lower total C emissions than 1 GtC. (Göran Berndes, Chalmers University of Technology)	Bernhard to look into this.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-831	A	39	49			gives 0.5-1 GTC/yr “currently” avoided emissions. Calculations to be made comparable with ch 8 p. 21 line 32, solving the discussion with ch 9 authors, who state in ch.9, p22. line 12 that there is no sink. Note also that in several places of the report, including the glossary biomass has been given a classifier “carbon neutral”. (Peter Bosch, IPCC TSU WGIII)	Bernhard to look into this.
4-832	A	40	4	4	40	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 agreed that we would do this. “biomass sources”
4-833	A	40	6	40	6	"...demand...": should be "...supply..." (Göran Berndes, Chalmers University of Technology)	Agreed
4-834	A	40	7	40	12	To give a balanced picture also the down side should be mentioned, namely that increased biomass production can lead to degradation of biological diversity if not carried out responsibly. There are several examples of this already. (Kenneth Möllersten, Swedish Energy Agency)	Agreed. See earlier comment on this topic.
4-835	A	40	7	40	9	"Improved...loadings": the generation of additional environmental benefits through proper location, design and management of energy plantations could be elaborated more. Could write: "If located, designed and managed in specific ways, bioenergy plantations can generate additional environmental services such as reduction of nutrient leaching and soil erosion; soil carbon accumulation leading to improved soil fertility; removal of cadmium and other heavy metals from cropland soils; increased nutrient recirculation and improved treatment efficiency of nutrient-rich drainage water and pre-treated municipal wastewater and sludge; provision of habitats and contribution to enhanced biodiversity and game potential in the agricultural landscape." Further if you like: "Given that revenues –corresponding to the estimated economic value of the provided environmental services– can be linked to such plantations, the economic performance of those can improve substantially." Research and practical implementation in Sweden have resulted in the accumulation of valuable knowledge into how esp. Salix cultivation can be located, designed and managed in order to provide additional environmental services. Specific applications are becoming established land use practices, and so-called multifunctional bioenergy plantations are increasingly being referred to as a promising option for improving the environmental performance of agriculture, while at the same time obtain additional revenues . Presently, about 10 % of the municipal wastewater sludge in Sweden is recycled in Salix plantations, and about	Yes. In combination with the earlier comments on negative effects, could provide a balanced picture. 1 sentence plus reference.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						25 facilities treat landfill leachate in Salix plantations. A number of municipalities and small villages have established Salix/wastewater treatment systems already. Links also to text on page 43 (line 27-28). Just let me know if you want more info. References for the Swedish experience: (i) Berndes, G and P. Börjesson (2002). Crediting of plantation-induced carbon sinks: the case of Salix production in Sweden. 12th European Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection. Amsterdam; (ii) Berndes, G., Fredriksson, F. and Börjesson, P. (2004). Cadmium accumulation and Salix based phytoextraction on arable land in Sweden. Agriculture, Ecosystems and Environment 103(1): 207-223; (iii) Berndes, G. and Börjesson, P. (2004). Low cost biomass produced in multifunctional plantations –the case of willow production in Sweden. 2nd World Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection, Rome, Italy, 10-14 May 2004; (iv) Börjesson, P. and Berndes G. (2006). The prospects of willow plantations for wastewater treatment in Sweden. To appear in Biomass and Bioenergy. (Göran Berndes, Chalmers University of Technology)	
4-836	A	40	7	40	7	"...surplus productive or marginal lands". In this context, "surplus productive land" normally refers to agricultural land not used for production of traditional food/feed/fiber crops given prevailing/projected conditions. All readers may not understand "surplus" that way, so could be good to be more precise. Similarly for "marginal lands": could examplify, e.g., "grazing land". (Göran Berndes, Chalmers University of Technology)	Use right terminology.
4-837	A	40	9	40	10	"Low production costs...": applies also to Latin America and E. Europe (Göran Berndes, Chalmers University of Technology)	Agreed.
4-838	A	40	10	40	12	The sudden jump form low production costs for biomass to high tech production technologies seems odd here. The technology to convert cellulose to ethanol is extensively researched. The energy input/output of this system is generally not in doubt making the second sentence odd here. The conversion of cellolose to glycerides should first be published and accpeted as a viable possibility before being mentioned in this IPCC report! (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	Agreed. Need to rewrite energy inputs anyway. Remove glycerides.
4-839	A	40	10	40	10	This line indicates East Asia(was this supposed to be South East Asia?) but production costs are lower in South East Asia than in East Asia which include Japan and South Korea. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Agreed.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-840	A	40	10	40	12	"Biochemical...marginal": need to be more specific and elaborate more when treating energy input/output ratios of different biofuel options. Should explicitly dicuss both differences in: (i) feedstock supply (energy input/output in producing, e.g., cereals vs sugar vs lignocellulose) and (ii) conversion to biofuels (and power and heat). Beyond energy input/output ratios, you should expand to discuss C benefits of different options (more than what is presently said on lines 18-20 on page 40). Lots of studies available, but why not rely on Bernhard's work based on GORCAM since he is involved in writing this chapter anyway. (Göran Berndes, Chalmers University of Technology)	Agreed. Rwrite i/O section. Bernahd to cite optimizing paper which refers to max GHG credits per unit of limiting resource.
4-841	A	40	10	40	10	This line indicates East Asia(was this supposed to be South East Asia?) but production costs are lower in South East Asia than in East Asia which include Japan and South Korea. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	See 839.
4-842	A	40	12	40	12	Let us not perpetuate bad science here with the statement "..energy input/output ratios can be marginal." See http://www.eere.energy.gov/biomass/net_energy_balance.html. The statement here is also in conflict with the statement on p. 42 line 48 to top of p. 43. (Stan Bull, National Renewable Energy Laboratory)	Agreed.
4-843	A	40	13	40	13	"input/output" or "output/input" (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Agreed. Rewrite I/O.
4-844	A	40	15	40	18	What about bagasse? (Kenneth Möllersten, Swedish Energy Agency)	Agreed.
4-845	A	40	18	40	18	Add "sustainably grown" in front of 'biomass'. (Kenneth Möllersten, Swedish Energy Agency)	Agreed.
4-846	A	40	18	40	20	Statement about net carbon is true. But it has been so controversial that I suggest the impact of bioenergy on carbon dioxide emissions is worthy of a full paragraph of explanation. (Stan Bull, National Renewable Energy Laboratory)	Yes agreed., Bernhard. Refer to IPCC guidelines how they treat biomass.
4-847	A	40	19		39	a few of ref's not in Ref list, line 19, 28 and 38 (Ad Seebregts, Energy research Centre of the Netherlands)	Agreed.
4-848	A	40	22	40	25	text is similar to that on page 39, line 39 ->... (Göran Berndes, Chalmers University of Technology)	It all goes into section on traditional biomass.
4-849	A	40	22	40	40	The opportunity to increase the efficiency of biomass use in developing countries is an enormously important one. It is good that the issue has been raised here, but it warrants elaboration. This especially true given the link between low efficiency biomass use and deforestation in the developing world - a topic of ever growing	This also to traditional biomass section. Reference to nrb discussion int eh DM.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						concern. At a minimum, it would be good to include an estimate of the net carbon benefits of improving the efficiency of subsistance heating and cooking uses of biomass since this might be an option to conversion to fossil fuels. Unfortunately, I do not know of an estimate to cite. (Reid Miner, NCASI)	
4-850	A	40	24	40	24	In some countries? (Kenneth Möllersten, Swedish Energy Agency)	Agreed.
4-851	A	40	31			In the light of the wording at line 14 of the preceding page, it is odd to see "There are synergies …" here. There 'may' or 'can' be seems more appropriate. This would also link better with the wording at page 42, line 35 "… to avoid serious negative impacts ..." (Michael Jefferson, World Renewable Energy Network/Congresses)	"can be" is agreeable.
4-852	A	40	33	40	34	Such competition already occurs. Eg the removal of productive rain forest to give way to palm oil plantations in SE Asia. (Kenneth Möllersten, Swedish Energy Agency)	Yes this is true, see CDM leakage discussions. Accept.
4-853	A	40	38	40	38	Ref not given in the ref list. (Kenneth Möllersten, Swedish Energy Agency)	Agreed.
4-854	A	40	42	42	30	When reviewing biomass conversion technologies, should mention that biological conversion and thermochemical conversion technologies can be integrated in a single biorefinery such that bioconversion is used to process the carbohydrate fraction to ethanol and thermochemical conversion (i.e. gasifiaction) is used to process the lignin-rich residue to fuels (e.g. FT fuels) and/or electricity. (Lee Lynd, Dartmouth College)	Agreed.
4-855	A	41	1	41	2	increased efficiency in power production is an important goal and driver that is not mentioned. (Kenneth Möllersten, Swedish Energy Agency)	Agreed. Should be used efficiently becuase resource is constrained.
4-856	A	41	4	41	5	Regarding Figure 4.3.15: biochemical conversion and thermochemical conversion can also be combined such that the carbohydrate fraction is converted biologically with the lignin-rich residue being converted thermochemically. 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	Andre needs to revise this figure.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						technology. See www.brienergy.com. (Lee Lynd, Dartmouth College)	
4-857	A	41	7	41	13	Two different attributes of biomass are being confused here: Low energy content (= MJ per kg) and low energy density or dispersion of biomass (tonne per ha). A separate issue to be mentioned here are handling and associated storage problems. (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	Agreed. Improve wording.
4-858	A	41	32	41	32	"Biomass can easilly...": the word "easilly" is not nessecary + it's vague and might also meet objection, e.g. from people having the perspective of cofiring biomass with coal in large power plants with high thermal efficiency. (Göran Berndes, Chalmers University of Technology)	Delete “easily”.
4-859	A	41	47	42	7	It is missleading to say that biomass gasification is "easier" than coal. Please read the literature and focus on the real problems in the real gasifiers (fuel handling, tar formation, fouling, alkalis...) that have been for decades "near" commercialization. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Need a good reference for gasification. Bernhad ask Gasification task, HOfbauer. Check the ref to 4.3.1.1.
4-860	A	42	3	42	5	Firstly, why this discussion on energy balance only for the case of biomass gasification and not for other conversion technologies? Therefore, either discuss energy balance under each technology, or, even better, in a comprehensive way under the next section 'Overall performance and impacts.....'. A range rather than just one example value should be presented here because the performance may vary extensively. Eg., for the case of forestry residue extraction, Börjesson and Gustavsson (1996) estimate that 2.9 kg CO2 from fossil fuels is emitted per GJ forestry residues extracted. On the other hand, as the result of a comprehensive environmental life cycle assessment of fuel supply from dedicated eucalyptus plantations, Dowaki et al. (2002) show that 21 kg CO2 from fossil fuels is emitted per GJ biomass extracted. Ethanol production based on maize in North America, which can have a terrible energy balance, is another example worth noting. Börjesson P, Gustavsson L. Regional production and utilization of biomass in Sweden. Energy 1996;21(9):747-764.Dowaki K, Ishitani H, Matsuhashi R, Sam N. A comprehensive life cycle analysis of a biomass energy system. Technology 2002;8:193-204. (Kenneth Möllersten, Swedish Energy Agency)	Need energy balance for all technolgoeis. Maybe an overview table of GHG balances of different routes. Use Task38 to help. Use Norway workshop.
4-861	A	42	4		29	5 ref's not in Ref list: lines 4, 10, 19, 25, 26, 29 (Ad Seebregts, Energy research Centre of the Netherlands)	Agreed.
4-862	A	42	7	42	10	Why do you not include other heat options from biomass, SNG or syngas?? (Monique Hoogwijk, Ecofys)	This should not be under biogas. Reject.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-863	A	42	7	42	10	This section on biogas could be expanded to mention how the biogas is used. Including the upgrading requirements for uses such as distribution to filling station for gas fueled vehicles. (Göran Berndes, Chalmers University of Technology)	Agreed. Sweden for transportation as example, CHP etc.
4-864	A	42	11	42	29	There is an opportunity to mention the need to address concerns about conventional oil availability by expanding the availability of biofuels for transport. (Michael Jefferson, World Renewable Energy Network/Congresses)	Ok, because biofuel is the only alternative, besides coal to liquid, It is the only RE alternative except hydrogen from RE.
4-865	A	42	11	42	30	Refer to chapter 5 (Monique Hoogwijk, Ecofys)	Agreed.
4-866	A	42	11			It would be useful to include also info on the performance of biofuels with respect to emissions of air pollutants and especially VOCs, compared to other convnetional fuels used in the transport sector (gasoline, diesel oil, natural gas). (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Send this comment to transportation chapter.
4-867	A	42	18	42	21	For some time there has been ethanol production based on residues in a sulfite pulp mill in Sweden but that is a very special case and care should be taken so as to not confuse this with conversion of ligon-cellulose to ethanol in the 'direct' sense.The text makes it sound las there is commercial activity in the field of fermentation based on liqno-cellulosic material in Sweden. Such is not the case. There is a pilot-scale demonstration plant heavily subsidised by the government. (Kenneth Möllersten, Swedish Energy Agency)	Agreed.
4-868	A	42	20	42	21	Mainstream technolgy (sugar and starch to ethanol) and new technology in pilot plants should not be confused here. Sweded uses ethanol form sugar and starch to ethanol technology. Lignocellulsoe to ethanol is experimental. (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	Agreed see 867
4-869	A	42	21	42	21	Swedish ethanol production based on lignocellulosic feedstocks has not yet reached a state where it is commercially viable. At Domsjö i Örnsköldsvik in northern Sweden, 13,000 cubic metres of sugar-based ethanol is manufactured from sulphite pulp and treated with lye. Stating that lignocellulose-based ethanol prduction is commercially undertaken in Sweden, based on this activity, is in my view missleading. In Sweden, we have an ethanol PILOT factory located beside SEKAB, Sweden's primary ethanol distributor, in Örnsköldsvik, Sweden. The daily capacity is approximately 400-500 liters of ethanol. To produce that amount, 2 tons (dry mass) of saw dust or another raw material that contains lingocellulose is needed.	Agreed see 867

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						Much of the funding comes from the Swedish Energy Agency. I have not read the ref. Lawford & Rousseau 2003, so I don't know if this study mentions Sweden or only Canada. (Göran Berndes, Chalmers University of Technology)	
4-870	A	42	22	42	23	Conversion of lignocellulose to glycerides should be referenced if possible or not mentioned here. (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	Delete Glycerides.
4-871	A	42	25	42	25	Newer reference: http://www.nrel.gov/docs/fy00osti/28397.pdf (Stan Bull, National Renewable Energy Laboratory)	Agreed.
4-872	A	42	28	42	29	Fischer-Tropsch is only viable at a large scale contrary to anaerobis digestion. (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	Agreed.
4-873	A	42	28			Also mention the Dupont commercial venture in the US. (Stan Bull, National Renewable Energy Laboratory)	Ask Stan Bull about this (Ralph).
4-874	A	42	30	43	30	Refer top chapter 8 for the impacts, they also say something on emissions and biodiversity. They cover also Non-CO2 GHG emissions, should also be mentioned here. In addition the issue of biodiversity should be mentioned, not always positive (e.g. work EEA, work RIVM/MNP, IMAGE Team). (Monique Hoogwijk, Ecofys)	Agree.
4-875	A	42	31	43	29	There is an opportunity to mention the potential for engaging the agricultural community, especially in many industrialised countries, in expanding biomass/biofuel availability. Shifting support from food and feed production, especially where there is a prospect of surpluses, should be given greater emphasis (as indicated on page 43, lines 28/29). (Michael Jefferson, World Renewable Energy Network/Congresses)	Agreed. Mention briefly here and refer to ch 8.
4-876	A	42	31	43	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)	Bernhard to reivew and possibly refer.
4-877	A	42	33	42	35	"as other energy sources increase faster than bioenergy." I agree that there are sources that may increase faster than biomass to supply electricity, but for liquid fuels, there isn't any other alternative to petroleum at this time. (Stan Bull, National Renewable Energy Laboratory)	Improve language. Think of tar sands etc. Not be too generic. Coal to liquid.
4-878	A	42	35	42	35	the inclusion of biodiversity almost looks as though the authors felt they should say	We will have a para on all these issues.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						something yet did not know what to say. Biofuels, depending on species, etc. could either enhance or degrade biodiversity. The topic is discussed in better detail in WG3 ch 9 and there may need to be coordination between the two groups (and with WG2) on this topic. (Jeff Price, California State University, Chico)	
4-879	A	42	36	42	46	This section lacks appropriate references. It is important to note that, once in the atmosphere, CO2 has the same impact on the earth's radiative balance, regardless of its origin. Consequently, carbon capture and storage will have the same outcome independent of whether the carbon has a fossil or a biomass origin and, thus, CCS from biomass is 'good' whether or not the process is carbon-negative. The idea is forwarded that biomass with CCS has been widely promoted as a way to address ACC. This is misleading and not based on a thorough review of existing literature. Indeed, if biomass is sustainably produced and CCS is deployed, the total system yields negative CO2 emissions (Oberstiner, 2001). The option to implement negative emissions enables human-induced removal of CO2 from the atmosphere and it has been suggested by few studies that this could reduce the stabilisation cost (Eg Azar et al, Climatic Change). The opportunity for globally negative emissions, however, is far-fetched and should not be overemphasized; It has also been suggested that negative emissions from bioenergy with CCS could hava a value as an opportunity to off-set emissions from other countries. Williams (1998) proposes that negative emissions generated could be used to permanently off-set emissions generated by another party. CCS from biomass can be part of a least-cost mitigation path, eg. in countries with few large point emissions of fossil CO2. Due to low existing CO2 emissions from the power production system, common low-cost mitigation options such as end-use efficiency strategies or fuel-switch from oil or coal to natural gas or biomass in power and heat production have a potential to reduce emissions significantly in such countries and reduction costs for bioenergy w CCS could be competitive (eg, Möllersten et al.,Energy, 2003). CCS from biomass may also be enticing from an industrial perspective. Examples of point emissions of CO2 from biomass can be found in the pulp and paper and sugar/ethanol sectors, see eg Möllersten et al., Biomass and bioenergy, 2003. Likewise, CCS from biomass could be included in least-cost mitigation paths for these industries regardless of emissions being negative or not. Also, the idea of charcoal sequestration goes back to Seifritz [1993] who suggested that massive implementation of charcoal sequestration in developing countries could be implemented to off-set fossil emissions from industrialised countries. Other	Move to CCS section. Ralph to review. Cite latest publications from Peter.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						detailed comments: i) The Read and Lermit paper does not at all quantify a level below which biomass with CCS becomes critical. There is no explicit mention of a 450 stabilisation to be found except in a "hypothetical" table of no quantitative significance. The Read and Lermit paper also does not address the cost of achieving stabilisation targets or the cost reduction due to using biomass with CCS. If this para should remain unchanged concerning information provided then appropriate references must be added. ii) The modelling performed by Read & Lermit was flawed by an over-simple characterization of the carbon cycle, which led to a significant overestimate of the effectiveness of bio-energy based of forest plantations alone. This might be worth noting. iii) There are serious concerns regarding the stability of charcoal stored in soil which should be addressed if this method is put forward as a means for long-term carbon storage. iv) Much of the carbon is used-up in a gasification process, so how efficient would such a process be for charcoal carbon storage? Would not pyrolysis be a more suitable process? And why should it be small-scale gasification? What's inappropriate about with large-scale? v) In the last sentence the word 'rapidly' should be clarified. What exactly is meant by 'rapid'? (Kenneth Möllersten, Swedish Energy Agency)	
4-880	A	42	37	42	39	Additional reference: Azar, C., Lindgren, K., Larson, E, Möllersten, K 2005. Carbon capture and storage from fossil fuels and biomass – Costs and potential role in stabilizing the atmosphere, Climatic Change, forthcoming (Göran Berndes, Chalmers University of Technology)	Accept.
4-881	A	42	39	42	46	Aside from the well-known issue of high-alkalinity in the proposed soil amendment, the concentration of heavy metals in this proposed soil amendment will need to be carefully monitored. There already is a body of literature from coal gasification that should raise warnings about the trace metals distribution in this proposed scheme, and none of the studies on gasifier products find them to be benign. See: Chu, P., A Study of Gasification Emissions from Gasification-Combined Cycle Power Plants," EPRI TR-106619 (June 1996). (Richard Doctor, Argonne National Laboratory)	Ralph will deal with this – rewrite.
4-882	A	42	49	43	1	This statement is confusing as biomass to electricity and biomass to transporatation fuels have very different ratio's: For transportation fuels ration is much lower 1.5 to 5 maximal (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	Deal with this as part of a central table and GHG bbalance overview.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-883	A	42	0	43		Table 4.3.3. and related text: some kind of summary of the possible down-sides of increased biomass use for energy purposes could/should be added. For instance: are there possible conflicts with food production, with biodiversity etc. when increasing bioenergy production? These aspects are very different in developing countries and in industrialised countries. Due to EU CO2 emission trading, raw materials for industry are already being directed to energy uses in Scandinavian countries. This can not be considered a positive issue for the national economy nor a sensible use of resources. (Sanna Syri, VTT)	Already agreed to do this. Good point. Combine negs and pos in one place.
4-884	A	43	1			ref not in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Agreed.
4-885	A	43	11	43	18	these restrictions rarely acts one by one, however this text makes it sound so. (Kenneth Möllersten, Swedish Energy Agency)	Agreed.
4-886	A	43	11		18	mitigation belongs to section 4.5? To move? (Ad Seebregts, Energy research Centre of the Netherlands)	Let'S leave it here but then at the end point to mitigation chapter. See page 56 on biomass mitigation. Some text from there (Rankine etc) should be moved here. Only bm quantities and mitigation costs should be in the mitigation chapter.
4-887	A	43	11	43	18	Here is the discussion of impacts on GHG or CO2 emissions that I mentioned under p. 40 l. 12. It would be useful to critically think through what general biomass conclusions you want to make at the beginning, and which at the end, of this section so that similar thoughts are not scattered around. (Stan Bull, National Renewable Energy Laboratory)	Agreed. Reorder. Subsection of GHG aspects of biomass. Here, not in mitigation chapter, because it is per unit land (biomass).
4-888	A	43	20	43	20	Delete table, is not very informative (Monique Hoogwijk, Ecofys)	Expand table, to have pos and neg aspects.
4-889	A	43	23		24	check consistency with page 42 lines 32/33 (Ad Seebregts, Energy research Centre of the Netherlands)	Need to discuss with Andre whether this statement is even true. Some traditional biomass may not be renewable.
4-890	A	43	23	43	30	Please either refer to figures on costs etc, or mention them here. If there are analyses that indicate the bioenergy will maintain a position as the highest contributor, check with Chapter 3, ideal way for meeting Chapter 3. Within their low-level stabilisation scenarios, some references indicate the same conclusion (Monique Hoogwijk, Ecofys)	Refer to costs of mitigation in mitigation chapter.
4-891	A	43	27	43	28	See comment above re: Ch. 4, pp 40, line 7-9. (Göran Berndes, Chalmers University of Technology)	Agreed.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-892	A	43	27	43	27	Modify the sentence by: "… including biological carbon sequestration and CCS opportunities,…" (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Let's mention this only in the CCS chapter.
4-893	A	43	47	43	27	Does 'sequestration' refer to sequestration in standing biomass or CCS? (Kenneth Möllersten, Swedish Energy Agency)	See 892.
4-894	A	43	49	44	4	this § do not reflect the contrasting characteristics between : - high enthalpy geothermal fields, located in geodynamically active regions, allowing for direct electricity production from natural steam by drilling at shallow (less than 2000m) depth ; - low enthalpy geothermal fields, located in sedimentary basins of geologically stable platforms, allowing for direct heat extraction for direct use for district urban heating or industial or other (leisure, balneotherapy...) applications. (VARET JACQUES, BRGM)	"Considerations" from here onwards are draft by Bernhard. Seems a valid comment and should be incorporated.
4-895	A	43	0			delete "proportion" of as being both technically incoprrect and unnecessary. (Roger Gifford, CSIRO)	Could not find the word "proportion" on page 43. I did a text search of the word proportion in the entire chapter 4, and there was no place wehre it did not seem appropriate. Thus reject comment.
4-896	A	44	6	44	9	add a sentence : these problems arise in exploitations that do not practice reinjection of the geothermal fluid. The use of this technology not only solves these problems but also allows for a more sustained use of geothermal fields by maintaining a constant pressure in the geothermal reservoir. (VARET JACQUES, BRGM)	Generally agree, but tie this to the already mentioned re-injection in the first para of Geothermal section.
4-897	A	44	11	44	17	The report does not mention advanced geothermal technologies and techniques such as hot dry rock and enhanced geothermal systems (EGS). The US Department of Energy projects a large long-term potential of 88 GW in the US for EGS, with 36 GW projected to be developed by 2050 if DOE R&D goals are met. Source: DOE, Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs (FY2006- FY2050), Long-term Benefits Analysis of EERE's Programs (Chapter 5), p. 5-12 to 5-14. (Steve Clemmer, Union of Concerned Scientists)	Agreed. Should be mentioned.
4-898	A	44	19	44	22	instead of "however" write that "sevaral technologies for shallow geothermal heat extraction are available, including direct flow from a well drilled in the aquifer, horizontal or vertical grids and loops, or even "intelligent" thermal fondations. Costs vary widely according to the choice;" (last sentence unchanged) (VARET JACQUES, BRGM)	Seems a good addition, as long as the metnioning of half of capital costs remains.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-899	A	44	27			COMMENT: Concentrated Solar Power (CSP) be discussed in an indipendent section under 4.3.3.5 Solar Thermal, not in 4.3.3.5.1High Temperature. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Yes, and Eric has also recommend this. Separate solar thermal (for hot water) from concentrated solar thermal electricity, in separate sections.
4-900	A	44	27			Concentrated Solar Power (CSP) be discussed in an indipendent section under 4.3.3.5 Solar Thermal, not in 4.3.3.5.1High Temperature. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	See 899
4-901	A	44	40	44	43	While the capital cost estimates for biomass gasification seem reasonable, the estimated generation costs of 10-12 c/kWh are high. Based on assumptions from the Energy Information Administration's used in the National Energy Modeling System in the US, generation costs are in the range of 6-8 c/kWh (20-year levelized), depending on fuel costs. This assumes an 80 MW biomass integrated gasification combined cycle plant, capital costs declining from $1,750/kW in 2005 to $1,200 in 2025, variable O&M costs of 2.96 mills/kWH, fixed O&M costs of $47.18/kW, heat rate of 8,711 Btu/kWh, a capacity factor of 83%, a fixed charge rate of 16.8% (to calculate annual capital carrying charges), and fuel costs ranging from $20-$50/dry ton. (Source: EIA, Assumptions to Annual Energy Outlook 2005, pp. 67, 130, 131, 135, 136; online at www.eia.doe.gov.) (Steve Clemmer, Union of Concerned Scientists)	This comment is misplaced. Bernhard will deal with it in biomass section.
4-902	A	44	41	44	42	Not sure what the source is. Philibert 2005 (reference in the general comments on chapter 4) suggests 0,6% of emerged lands with solar systems with a conversion efficacy of 10% would provide enough energy to cover total needs as forescated for 2030 by the IEA. (Cédric Philibert, International Energy Agency)	Should be implemented including the reference. If questions remain, contact Cedric.
4-903	A	44	44			figure 4.3.16: The color scale should be provided (Marco Mazzotti, Institute of Process Engineering)	Agreed.
4-904	A	44	46			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/3.2-billion-solar-roofs-program-proposed-for-california (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Agreed.
4-905	A	44	48	44	49	There is no such thing as 21 GW installed capacity of solar thermal electricity today. There are 354 MW in California, 1 MW under construction in Arizona, 10 MW (tower) under construction in Spain, 68 MW about to start being built in Nevada, 50 MW about to start being built in Spain and another 50 MW to follow,	This info should be included. Not sure why the text says 21 GW which is obviously wrong. The reference mentioned will be accessible through Clive.

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						and various solar fields from 4 to 30 MWe to be added in the coming years to existing or to-be-built fossil fuels plants in Algeria, Australia, Egypt and Morocco. Other projects exist in India, Iran, Israel, Italy, Jordan, Mexico, RSA, Spain and the US (800 MW of dishes in California) less likely to be in construction at the time of the publication of AR4 (on RSA, see Clive Turner, Greg Tosen, Wendy Poulton, Tony Stott and Siven Naidoo, Technology and climate change policy in South Africa, Proceedings of the IPCC Expert Meeting on Industrial Technology Development, Transfer and Diffusion, September 21-23, 2004, Tokyo) (Cédric Philibert, International Energy Agency)	
4-906	A	45	6	45	7	The efficiency estimates for central solar thermal seem low. The US Department of Energy and National Renewable Energy Laboratory project capacity factors of 53% in 2005, 65% in 2010 and 72% in 2020. Source: DOE, Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs (FY2006- FY2050), Chapter 5, page 5-22. (Steve Clemmer, Union of Concerned Scientists)	I think this may be a misunderstanding. Capacity factor is not the same as peak efficiency. But the capacity factors could be mentioned nevertheless, making use of the proposed refrence.
4-907	A	45	13	45	16	Biomass certainly is an option as a back-up fuel for solar thermal electricity, but what is more important is the fact that this technology can provide guaranteed and even dispatchable electricity for a minor additional cost, since the use of a back-up fuel or heat storage will use the same "classic" parts of the plants (vapor generators, turbines and power generators) than the solar part, contrary to wind or PV. This could be illustrated by the scheme of the forthcoming Andasol plant to be built in 2006 in Spain, which is reproduced on slide 13 of the attached powerpoint presentation. (Cédric Philibert, International Energy Agency)	Yes, should mention this. Look up PPT slide.
4-908	A	45	18			COMMENT: create a new subsection entitled "Solar Heating and Cooling" and put the discussion in 4.3.3.5.2 Low Tempreture into this, therefore, not under "Solar Thermal". (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	908-949: Eric. Comment agreed. Eric also proposed this.
4-909	A	45	18			Create a new subsection entitled "Solar Heating and Cooling" and put the discussion in 4.3.3.5.2 Low Tempreture into this, therefore, not under "Solar Thermal". (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	See 908
4-910	A	45	23			Not solar thermal, but yes on just solar. (Stan Bull, National Renewable Energy Laboratory)	Yes this needs clarification.
4-911	A	45	26			Is it conceivable that almost 3 million km^2 of land (including rooftops)	I have not been able to find text in FOD that

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						could/would be made available for the capture of solar energy? It is hard to believe that even 10% of this land area, ~ 300,000 km^2), would be available, much less that the resources are available to produce solar PV paneling covering 1.5 million km^2.. (Estimates I have seen indicate that cumulative production of solar PV panels comprise an area of less than 10 km^2, although the solar thermal collector area apparently now exceeds 100 km^2, according to the Report (at p.45, line 26)). If 300,000 km^2 were dedicated to solar PV, the solar "potential" is reduced to 163 EJ/yr. But even this amount exceeds capabilities given that the resource is intermittent and thus only a very small amount could be delivered directly and safely to the grid (to prevent blackouts). Thus long before land becomes a (resource-related) constraint, the expansion of solar PV would encounter a technological constraint in the absence of an enabling technology that makes large scale storage possible (Christopher Green, McGill University)	mentions 3 million km2 of land. Line 26 on page 45 talks about actual area of solar thermal collectors.
4-912	A	45	26	45	27	2003 data are now available from: Weiss, W., Bergmann, I. and Faninger, G. (2005) Solar Heating Worldwide: Markets and Contribution to Energy Supply, International Energy Agency, Solar Heating and Cooling Programme, Paris. Available from www.iea-shc.org. The estimate for the end of 2003 is 132.4 million m2. (Danny Harvey, University of Toronto)	Great to get a newer reference!
4-913	A	45	34			ref not in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Agreed.
4-914	A	45	35			Change uptake to installation (Stan Bull, National Renewable Energy Laboratory)	Ok
4-915	A	45	43	45	44	I suspect that the 42 TWh figure is for IEA member countries only (and that the reference is IEA 2004b). If one takes a global capacity of active solar systems at about 140 GW (thermal) today, and the production of usable heat only 1000 hours per year (probably a conservative estimate, at least for China), then the global output would be 140 TWh. (Cédric Philibert, International Energy Agency)	Probably Cedric is correct, needs to be checked.
4-916	A	45	45			Mention here or after PV, the combination of PV and solar thermal. E.g. a reference could be: Zondag, H.A., et al., 2005, PVT roadmap: a European guide for the development and market introduction of PVT technology, paper presented at the 20th European Photovoltaic Solar Energy Conference, 6-10 June 2005, Barcelona, Spain (Ad Seebregts, Energy research Centre of the Netherlands)	Could be mentioned in half sentence, and add reference.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-917	A	45	46			I miss in this section some of the other advantages of PV (off-grid applications are mentioned): PV can avoid much of the external (damage) costs that other forms of power production entail. See also the previous reference. Typically, half of the investment costs required to break-even can be justified in terms of the (air pollution, climate change) damage costs that are avoided by deploying PV. I consider this very relevant information. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	This is true for any of the renewable options and should be mentioned in a generic chapter, not under PV.
4-918	A	45	48	45	49	The word 'annual' should be left out: by any time unit of measure (hour, day, week, month or year) the amount of solar radiation that reaches the surface of the Earth is 10,000 that what mankind consumes in terms of global primary energy. Given that there are 8,760 hours in a year, this implies that one hour's worth of solar radiation could theoretically be enough to (currently) provide mankind with one year of global primary energy consumption. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	This is correct. By the way, this sentence should anyway be moved to the beginning of the solar energy chapter, as it applies not only to PV.
4-919	A	45	49	45	50	and' should be replaced by 'to'. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	Reject.
4-920	A	45	0			Section 4.3.3.6 comment -- This whole discussion of PV is quite weak. (In contrast, the biomass section, for example, is well developed, in my opinion.) The concepts of 1, 2, and 3rd generation PV technologies has become quite common internationally, first developed by Martin Green of Australia. Current PV shipment data should be shown (attached in my presentation, or get updated from Maycock). There are many excellent references. Please check www.nrel.gov and/or www.eere.doe.gov for current info. Also, an excellent work was done recently on the future directions of research on PV, at www.sc.doe.gov/bes/reports/files/SEU_rpt.pdf, or the abstact at http://www.sc.doe.gov/bes/reports/abstracts.html#SEU. In addition, I will attach a file with my favorite graphics on PV that would augment your text. (Stan Bull, National Renewable Energy Laboratory)	Ok, should be improved. Eric can you do that?
4-921	A	46	1	46	3	I do not think the installed capacity is so hard to assess, but one has to take references that can be really compared in terms of year, system categories, countries, etc. Generally, one may take the IEA-PVPS survey report 1992-2004 as the best reference for systems in IEA countries (which account for a large fraction of the total). "Mayrock" should be" Maycock". (Wim Sinke, Energy research Centre of the Netherlands)	Agreed.
4-922	A	46	1	46	3	I do not think the installed capacity is so hard to assess, but one has to take references that can be really compared in terms of year, system categories,	See 921

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						countries, etc. Generally, one may take the IEA-PVPS survey report 1992-2004 as the best reference for systems in IEA countries (which account for a large fraction of the total). "Mayrock" should be" Maycock". (Wim Sinke, Energy research Centre of the Netherlands)	
4-923	A	46	1	46	3	I do not think the installed capacity is so hard to assess, but one has to take references that can be really compared in terms of year, system categories, countries, etc. Generally, one may take the IEA-PVPS survey report 1992-2004 as the best reference for systems in IEA countries (which account for a large fraction of the total). "Mayrock" should be" Maycock". (Ad Seebregts, Energy research Centre of the Netherlands)	See 921
4-924	A	46	1	46	5	The confusion over numbers is reflects the rapid growth rates. The Greenpeace numbers are for the end of 2003, while the Martinot numbers are for the end of 2004. Grid-connected pv is growing at 60%/annum, and the rest at about 17% (Martinot 2005) which would seem to belie the statement at lines 12 and 13 of the same page which implies that most of the growth is off grid. When the 2005 numbers are published (soon) they will no doubt have leapt enormously again (Steve Sawyer, Greenpeace International)	Eric please modify text using latest numbers.
4-925	A	46	2	46	5	Total installed capacity should not be that hard to assess at all: only, some discrepancies can be found, as counting is never 100% perfect, and assignment to a given year is subject to some uncertainty. Also, as the market is so rapidly growing, typically, numbers a few months old are often already out-dated. With the indicated annual addition, Maycock and Martinot are likely to be consistent (these two publications differ by 1-2 years, hence a difference in capacity of at least 1000MW). Also Greenpeace may be consistent, for example, when in their 2004 publication, the actual numbers refer to 2002 deployment. So, be more careful with formulating here - possibly expand a bit along these lines. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	Ok
4-926	A	46	2	46	2	Mayrock' should be 'Maycock' - see also the rest of the text. Allso: add in this line that we are talking of capacity of 'PV cells' here. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	Ok
4-927	A	46	4	46	4	COMMENT: replace new data, 1150MW in 2004 -> 1109MW in 2005 REFERENCE: IEA PVPS(Report IEA-PVPS T1-14:2005) (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Ok
4-928	A	46	4	46	4	Replace new data, 1150MW in 2004 -> 1109MW in 2005 REFERENCE: IEA PVPS(Report IEA-PVPS T1-14:2005) (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	See 927

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-929	A	46	11	46	13	COMMENT: Decentralised generation by solar PV is already economically feasible for villages with long distances to a distribution grid is misleading. If it is true, there is no need to subsidise electrification in villages. We suggest to replace the sentence with "Decentralized generation by solar PV is approaching a feasible stage for---". REFERENCE: REN21 Global Status Report 2005 p.31 (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	ok
4-930	A	46	11	46	13	Decentralised generation by solar PV is already economically feasible for villages with long distances to a distribution grid is misleading. If it is true, there is no need to subsidise electrification in villages. We suggest to replace the sentence with "Decentralized generation by solar PV is approaching a feasible stage for---". REFERENCE: REN21 Global Status Report 2005 p.31 (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	See 929
4-931	A	46	16	46	20	This paragraph on costs is too short. A few additions are essential. First, indeed, the cost reductions reached over the past three decades have been enormous, and not seen for probably any other energy technology. Second, the power generation costs through PV are still very high: readily a factor of 5 higher (if not 10), in many regions, in comparison to conventional electricity. Third, at least one reference on PV learning phenomena is needed: see e.g. van der Zwaan, B.C.C. and A. Rabl, "The learning potential of photovoltaics: implications for energy policy", Energy Policy, 32, 13, 2004, pp. 1545-1554. This reference also indicates what e.g. the required learning (deployment) investments are in order to reach break-even: typically around 50 billion US dollars. (Bob van der Zwaan, ECN (Energy research Centre of the Netherlands))	Yes should be taken on board.
4-932	A	46	19	46	20	The idea of BiPV suddenly pops up in passing, without the prominence that it deserves. I would break Section 4.3.3.6 into two subsections, one on centralized PV power, the other on BiPV, with a discussion of the relative costs, advantages, disadvantages, and trends in each. (Danny Harvey, University of Toronto)	Not sure wht BiPV is. Suggest to expand its mentioning, but not to create two subsections.
4-933	A	46	22	46	24	The efficiency numbers are not correct. Neither is the remark on the price (the report incorrectly speaks about "cost") In the context of this report one should refer to "total area module efficiency" and then monocrystalline silicon is in the range 13-15%, multicrystalline silicon 12-14%, with presently no significant differences in price on a per Wp level, see www.ipcrystalclear.info. (Wim Sinke, Energy research Centre of the Netherlands)	Agreed. But the term costs / Wp seems to be correct in this context?

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4-934	A	46	22	46	24	The efficiency numbers are not correct. Neither is the remark on the price (the report incorrectly speaks about "cost") In the context of this report one should refer to "total area module efficiency" and then monocrystalline silicon is in the range 13-15%, multicrystalline silicon 12-14%, with presently no significant differences in price on a per Wp level, see www.ipcrystalclear.info. (Wim Sinke, Energy research Centre of the Netherlands)	See 933.
4-935	A	46	22	46	24	The efficiency numbers are not correct. Neither is the remark on the price (the report incorrectly speaks about "cost") In the context of this report one should refer to "total area module efficiency" and then monocrystalline silicon is in the range 13-15%, multicrystalline silicon 12-14%, with presently no significant differences in price on a per Wp level, see www.ipcrystalclear.info. (Ad Seebregts, Energy research Centre of the Netherlands)	See 933.
4-936	A	46	23	46	23	How is this efficiency defined? (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Define. Peak efficiency or annual average?
4-937	A	46	30	46	30	Proper wording: "photoelectrochemical (dye) cells and other sensitized-oxide devices" (Wim Sinke, Energy research Centre of the Netherlands)	Probably accept.
4-938	A	46	30	46	30	Proper wording: "photoelectrochemical (dye) cells and other sensitized-oxide devices" (Wim Sinke, Energy research Centre of the Netherlands)	See 938
4-939	A	46	30	46	30	Proper wording: "photoelectrochemical (dye) cells and other sensitized-oxide devices" (Ad Seebregts, Energy research Centre of the Netherlands)	See 938
4-940	A	46	30	46	30	Not sure what 'photochemical' cells are; suggest dropping. As a point of information, (Stan Bull, National Renewable Energy Laboratory)	Not ure
4-941	A	46	34	46	35	"super thin flexible cells" is not PV jargon and confusing, one refers to "multigap concentrator cells" (Wim Sinke, Energy research Centre of the Netherlands)	Not sure
4-942	A	46	34	46	35	"super thin flexible cells" is not PV jargon and confusing, one refers to "multigap concentrator cells" (Wim Sinke, Energy research Centre of the Netherlands)	See 941
4-943	A	46	34	46	35	"super thin flexible cells" is not PV jargon and confusing, one refers to "multigap concentrator cells" (Ad Seebregts, Energy research Centre of the Netherlands)	See 941
4-944	A	46	35	46	40	Somewhere in here there should be mention of the potential of concentrator PV	Should mention?

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						systems -- ie, using concentrated sunlight focused onto a high-efficiency solar cell. While that technology has been around a long time, there has been a strong renewable of interest and R&D is expanding. See http://www.eere.energy.gov/solar/pv_sys_concentrator.html (Stan Bull, National Renewable Energy Laboratory)	
4-945	A	46	37	46	38	The challenge is not to replace crystalline silicon and thin films are certainly not yet simpler to make, but the challenge is to develop PV module technologies with low manufacturing cost (per Wp) at sufficient efficiencies (otherwise the area-related system costs may become too high). This may be achieved with different approaches and crystalline silicon is certainly one of them. The remarks on polymers, quantum dots and nano-structures are highly speculative ("will allow..."!) and should not be given here, It would be better to state it more neutral as I did. I fully agree that all of the listed options should be explored, though. (Wim Sinke, Energy research Centre of the Netherlands)	Can't comment on that. Eric?
4-946	A	46	37	46	38	The challenge is not to replace crystalline silicon and thin films are certainly not yet simpler to make, but the challenge is to develop PV module technologies with low manufacturing cost (per Wp) at sufficient efficiencies (otherwise the area-related system costs may become too high). This may be achieved with different approaches and crystalline silicon is certainly one of them. The remarks on polymers, quantum dots and nano-structures are highly speculative ("will allow..."!) and should not be given here, It would be better to state it more neutral as I did. I fully agree that all of the listed options should be explored, though. (Wim Sinke, Energy research Centre of the Netherlands)	See 945
4-947	A	46	37	46	38	The challenge is not to replace crystalline silicon and thin films are certainly not yet simpler to make, but the challenge is to develop PV module technologies with low manufacturing cost (per Wp) at sufficient efficiencies (otherwise the area-related system costs may become too high). This may be achieved with different approaches and crystalline silicon is certainly one of them. The remarks on polymers, quantum dots and nano-structures are highly speculative ("will allow..."!) and should not be given here, It would be better to state it more neutral as I did. I fully agree that all of the listed options should be explored, though. (Ad Seebregts, Energy research Centre of the Netherlands)	See 945
4-948	A	46	38	46	40	Confusing sentence "continued R&D…." mixed with "social welfare"?. Delete and look for several other wordy meaningless sentences around. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Agreed.
4-949	A	46	40	46	40	The net energy gain, Q, from photovoltaics should be considered. If a PV farm over	If we discuss energy embodied in

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						its lifetime can produce E joules of energy, for W Joules of energy investment, its energy gain, Q, is defined as Q = E/W. The total cost of producing a given amount of energy then varies as Q/(Q-1), with the result that if, for example, Q = 3, the total cost of producing a given amount of net energy, and the total resources required including land area, increase by 50%. Furthermore, the energy invested may have been provided from a valuable steady energy source, while the energy from the PV's is intermittent, so much less valuable. (Robert Goldston, Princeton Plasma Physics Laboratory)	infrastructure, then we should do the same for all alternatives. Maybe one overview diagram from the literature that covers all could be found. We should not put special scrutiny in this respect on only one energy source/technology.
4-950	A	46	41	47	12	This section on passive solar seems considerably understated. (Michael Jefferson, World Renewable Energy Network/Congresses)	This is correct, and the reason is that it is an issue for chapter 6.
4-951	A	46	43	47	12	Delete this section. It is redundant to Section 6. The topic more correctly belongs in Chapter 6. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	This is correct. The chapter chould be shortened and text sent to chapter 6. Suggest not to entirely delete.
4-952	A	46	47	46	49	Please check the numbers. The quota of space and water heating in total building energy is in Germany (a mid-latitude region) higher than 50 %. 50 % is not plausible also with respect to your number "30 % of energy use". If the numbers are vaild, buildings consume 60 % of total energy use, leaving only 40 % for traffic, industry etc. But I am not sure. May be there are other relations in the US and your numbers are valid as an international average. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	We should move this text into the buildings chapter.
4-953	A	47	15	48	3	The following sections elaborate on the potential of wave energy, which is described quite cursorily in this section of the Assessment Report. Hopefully this will enable a much more comperhensive and accurate assessment of the potential of this renewable energy option. I'll just concentrate on wave energy that is located relatively close to shorelines - within a few tens of kilometres, as this is a practical possibility for implementation. The coastlines of the world total about 8 x 10^8 meters. It is difficult to estimate the average wave power density throughout the world (clearly no such comprehensive study has been done) but, while there are many areas with high levels of energy, there are also many where this is not the case. Therefore, a reasonably conservative ball park figure of about 5 kW/m is generally accepted, though it varies markedly (this figure represents quite mild wave conditions). This means that there is about 4 TW (on average throughout the year) of wave power incident upon the world's coasts. Compare this with the current global power usage of 3.5 TW, and you can see where the generally accepted claim comes from, that global wave power is approximately equal to	This is a nice elaboration but much too detailed for this purpose. I suggest to capture the essence of this (especially the global potential estimates and the capacity factor issue) in 1-2 sentences plus 2-3 references.

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						current world usage. Given a capacity factor of about 40% for wave energy devices means that a peak capacity of 10 TW could be installed, but the full 10 TW would never be operating at the one time. Now, the distribution of average power densities throughout the world follows a general log-normal type shape. While the mean might be 5 kW/m, with the modal peak a bit less than this, there is still a substantial tail on the upper side. In fact, about 10% of the coastlines of the world have a density of 20 kW/m or more, and about 2% of the coastlines have densities of 30 kW/m or more. To be honest, one would only ever deploy wave energy devices in the better wave climates, so let's concentrate on the 2% of best sites. This means there is about 16,000 km of coastline with an average power density of 30 kW/m, equating to about 0.5 TW in total. To utilise this power, one would require about 400,000 wave energy devices, occupying a total of about 400 square kms. Given an efficiency factor of 40% (very likely in second generation devices), this total number of devices would provide an average output of 0.2 TW, with a rated peak output of 0.5 TW. This means that an area of only 20 km by 20 km could provide about 6% of the world's current power usage, although one would never place them in a square configuration like that. To be clear, when anyone speaks of wind power, it's always the rated capacity that is mentioned (not the year long average), so we should realistically be describing the potential of wave power as 0.5 TW, though this does not alter the fact that only 6% of current global energy usage could be provided by this 400 square kms of devices. Of course, one can increase this output by adding more capacity in regions of lesser power density, but this implies diminishing returns. By adding five times more devices, only about three times more power would be produced. All the same, a doubling might bring the total energy produced up to about 10% of current global usage. While clearly not solving the issue of climate change on its own, the production of 10% (or even 6%) of the world's energy from a totally sustainable source is something that should be considered as possible over teh coming few decades. (Tom Denniss, Energetech Australia Pty Ltd)	
4-954	A	47	15	48	10	In the ocean energy summary, it would be good to mention environmental impact concerns. Likewise for other summaries in which you've not discussed environmental impact. (Lee Lynd, Dartmouth College)	We need to treat this in a uniform fashion. Either brief mention of environmental issues for all energy types (which I recommend) or none.
4-955	A	47	15		48	Sec 4.3.3.8 On Ocean energy might usefully report latest status of devices at the European Marine Test Centre in Orkney, where a range of devices (including several tidal Steam devices) are operating. See also Carbon Trust report on the	Yes incorporate.

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						Marine Energy Challenge (www.carbontrust.co.uk) (Michael Grubb, Cambridge University)	
4-956	A	47	26	47	26	To say that Tierra del Fuego has a good climate (for anything), without further comment, begs the question of who would be around to use the energy produced there, and why. (Robert Goldston, Princeton Plasma Physics Laboratory)	Good point.
4-957	A	47	28		29	2 ref's not in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Insert refs.
4-958	A	47	39	47	40	It is a project name as well as a registered trademark. wave dragon -> Wave Dragon REFERENCE: "http://www.wavedragon.net" (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Ok, provide website
4-959	A	47	39	47	40	It is a project name as well as a registered trademark. wave dragon -> Wave Dragon REFERENCE: "http://www.wavedragon.net" (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	See 958
4-960	A	47	0			Section 4.3.3.8. The keyword and key numbers on cost, do not appear in this section. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Agreed, cost numbers should be inserted.
4-961	A	48	13			Section 4.4 Comment -- Good section, but it would be more useful closer to the beginning of chapter 4, before the discussion of individual sources such as fossil, renewables, etc. (Stan Bull, National Renewable Energy Laboratory)	Yes, will be merged with the earlier chapter.
4-962	A	48	21	48	21	Fig. 4.4.1:The figure descripes one (or perhaps two) shapshots of a system of flows. I did not understand the reason why it is named "dynamic". "Dynamic" suggests, that the shown pattern explains this own change. If this is the topic of the figure, more explanation is needed. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accepted – “dynamic” will be dropped
4-963	A	48	21			figure 4.4.1: The use of solar radiation to make hydrogen is of critical importance for our future. Why isn't it indicated with a big green circle in the figure? (Marco Mazzotti, Institute of Process Engineering)	Rejected – no reason
4-964	A	48	28	28	29	Unless the sun warms your belly on the beach there is always a carrier involved (air, water, electricity). In fact even in the beach example there is a carrier involved (H-Holger Rogner, IAEA)	Accepted – we will rewrite two sentences (delete the word "not”)
4-965	A	48	41	48	42	Biomass does not "produce" hydrocarbons. One large problem with biomass is how	Rejected – biomass is a hydrocarbon

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						to convert it to something that can replace hydrocarbons. (Wolter Elbersen, Agrotechnolgy and Food Sciences Groep of Wageningen University and Research centre)	
4-966	A	48	44	48	44	In Table 4.4.1, Fischer-Tropsch fuels are another important liquid carrier that can be derived from biomass (Lee Lynd, Dartmouth College)	Accepted
4-967	A	48	0			Table 4.4.1. Energy carriers of hydrocarbon substances: add LPG also in natural gasto row in liquid column (Johanna Wickstrom, World LP Gas Association)	Accepted
4-968	A	48	0	49		Somethere here the chapter could conclude with some broader comments about timescales and contributions. The broad assessment of the Carbon Trust is that offshore wind is about a decade to broad commercialisation, marine devices about two. (Michael Grubb, Cambridge University)	Accepted – we will do this on renewables (see page 67)
4-969	A	49	1			There is an opportunity here to relate the text back to the 'peak oil' discussion on page 25. (Michael Jefferson, World Renewable Energy Network/Congresses)	Noted
4-970	A	49	1	49	1	add LNG and LPG to the list of carbon-based petroleum products (Johanna Wickstrom, World LP Gas Association)	Accepted
4-971	A	49	7	49	7	clean, with the exception of electrosmog. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Rejected
4-972	A	49	7	49	7	Relatively little cost when the price charged to end-users does not fully reflect the production cost and when it does not include the externalities of electricity production (which may be high if electricity is produced by coal or oil). (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Accepted
4-973	A	49	10	49	10	"Production of electricity involves converting a primary energy source". Great teaching in this pargraph ¡ , but using a reference "(EPRI,2003)" to support this primary school statement is really too much. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted
4-974	A	49	11		12	Cannot conclude this from the Fig. 4.4.2. Moreover, may be very US specific (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted
4-975	A	49	23	49	24	Yes, all of these would reduce the production of greenhous gases. No, not all of these would increase the overall efficiency of energy use. Replacement of a	Noted

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						conventional power plant by a CCGT will do, but CCS in a coal plant will reduce efficiency. More wind power production will reduce efficiency in the back-up power plants, nuclear plants have a lower thermal efficiency than coal power plants and so on. Emission reduction has not an automatic benefit on efficiency. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	
4-976	A	49	24	49	24	"All of these would …and increase the overall effciency of energy use". This is not true for CCS . CCS is always associated to an energy penalty respect to a similar plant without capture. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted
4-977	A	49	26	49	26	'Early' would imply 1st to 3rd decades (if 4th to 6th would be mid-century). Is it really likely that NGCC with CCS and nuclear will dominate as early as before 2040? I recall that in recent scenarios CCS enters big-time mid-century. (Kenneth Möllersten, Swedish Energy Agency)	Noted In section 4.3.2 nuclear is not forecasted to dominate, but Gen4 NPPs may gradually be introduced into the market
4-978	A	49	26			On page 49, 26 "...Traditional electricity conversion technologies such as coal-fired, steam power plants are expected to be displaced over time with more advanced technologies such as combined cycle gas or advanced coal with carbon capture and storage (CCS), nuclear, fuel cells, wind, concentrated solar thermal, photovoltaics, and biomass. All of these would reduce the production of greenhouse gases and increase the overall efficiency of energy use. Previous IPCC and WEC scenarios (TAR, 2001; WEC, 2001) suggested that nuclear and combined cycle natural gas technology (CCGT) with CCS may become the dominant technologies for electricity production early this century. (Arjette Stevens, De Koepel)	Noted See also response to comment 4-977
4-979	A	49	33	49	33	What is meant by '..savings…were calculated for before and after each of the mitigation options…'? How can there be a saving before the mitigation option has been implemented? (Kenneth Möllersten, Swedish Energy Agency)	Accepted – we will change ”before” and “after” as a result
4-980	A	49	38	49	38	A reference is compulsary here and/or an outline of the assumptions used to reach these numbers (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted
4-981	A	49	43	49	43	Fig 4.4.3 does not specify life cycle emissions in the fig. caption. (Kenneth Möllersten, Swedish Energy Agency)	Accepted – we will check the reference
4-982	A	49	44	49	44	What fossil fuels did the authors have in mind that do not have particularly high	Rejected – the figure shows

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						emissions? The list seems to cover most important fossil fuels down to the relatively carbon-lean natural gas. (Kenneth Möllersten, Swedish Energy Agency)	
4-983	A	49	45	49	46	Is a reference really necessary for this generic piece of information? (Kenneth Möllersten, Swedish Energy Agency)	Accepted – delete the reference, and change the sentence.
4-984	A	49	45	49	46	In practice there is a problem in taking in fossil fuel shares and emission co-efficients for the three fuels, although what is written here is the proper way of proceeding. The UK Advertising Authority in December, 2005, reached an adjudication halving the assumed CO2 emissions reduction benefits using the usual approach of wind energy developers and the British Wind Energy Association. With coal use in electricity generation 30%, natural gas 40%, and oil 1% this seemed rather harsh. On the other hand, with the assumed phasing out of nuclear power (an assumption which may be reversed quite soon), UK wind energy developments could also arguably be saving virtually no emissions. (Michael Jefferson, World Renewable Energy Network/Congresses)	Noted
4-985	A	49	45			Where fossil fuel is replaced by renewable or nuclear energy, (Michael Bowman, GE Global Research)	Noted Nuclear will be inserted
4-986	A	49	47	49	49	When addressing life-cycle emissions, emissions for fuel transportation can be significant (coal transportation over long distances) and methane emissions from natural gas exploration can also be high (see for example Mann & Spath). (Kenneth Möllersten, Swedish Energy Agency)	Accepted - see comment 4-981
4-987	A	50	1	50	2	COMMENT: We support the assessment of greenhouse gas emissions from nuclear generation and other sources given in Figure 4.4.3 (WEC, 2004b) on page 110. JUSTIFICATION: Further evidence is provided in the publication VATTENFALL'S ELECTRICITY PRODUCTION SYSTEM -A QUANTITATIVE AND QUALITATIVE STUDY OF EMISSIONS OF GREENHOUSE GASES THROUGHOUT THE LIFE-CYCLE, DETHLEFSEN, Ulrika, ERICSON, Sven-Olov, SVENSSON, Björn, WIDEGREN, Karin and SETTERWALL, Caroline; Vattenfall AB Stockholm, Sweden, which is available on the following website. http://www.worldenergy.org/wec-geis/publications/default/tech_papers/17th_congress/3_4_14.asp#Heading4 Further information from Vattenfall is provided in the Lifecycle Assessment report available at http://www.vattenfall.com/files/environment/lca_2005.pdf. on page 22 where emissions from nuclear power are given as around 3gCO2/kWh. In "Full-energy-chain greenhouse-gas emissions: a comparison between nuclear power, hydropower, solar power and wind power" by Joop F. van de Vate International	Noted These and some other additional references will be included(earlier versions of documentation to Vattenfall´s LCA-studies were included in WEC2004 LCA-review

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						Journal of Risk Assessment and Management (IJRAM), Vol. 3, No. 1, 2002, nuclear has full energy chain emissions of 8.9 gCO2e/kWh, hydropower 16gCO2e/kWh, windpower 15gCO2e/kWh, solar thermal 50-80 gCO2e/kWh, solar PV 100-200 gCO2e/kWh. (Jonathan Cobb, World Nuclear Association)	
4-988	A	50	4		5	expectation may be 'wishful thinking' I am not convinced, certainly not in 'energy efficiency' terms. E.g. high gas prices may invoke investments in less efficient coal-fired plants rather than in more efficient gas CCGT's (Ad Seebregts, Energy research Centre of the Netherlands)	Noted – the sentence will be modified
4-989	A	50	10	50	11	Whether in the short run the expansion of electricity consumption leads to growth in the use of existing coal-fired facilities depends on the environmental legislation imposed with respect to air pollution and air pollutants' emissions, other policy instruments which internalize environmental externalities, as well as on market tools involving cap-and-trade systems. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Noted
4-990	A	50	13	50	16	What kind of policies could with respect to nuclear energy? (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Noted Text probably be shifted to another section
4-991	A	50	14			Section 4.4.1.1.2 comment -- Seems out of place here. Distributed renewables were discussed with renewables; distributed coal gasification should be discussed with coal. The section 4.4.1.1 on Power Technology Development is very appropriate, but should be phrased to cover all energy sources equitably focusing on common issues of interconnection, storage, power quality,applications, etc. (Stan Bull, National Renewable Energy Laboratory)	Noted – we will consider to move 4.3.1.1.1
4-992	A	50	24	51	13	It's my understanding that another compelling feature of distributed electricity generation is the ability to use waste heat for hot water and heating. See http://www.eia.doe.gov/oiaf/analysispaper/electricity_generation.html Following the "distributed energy" section with the "combined heat and power" section would be a logical transition. (Lee Lynd, Dartmouth College)	Accepted – comment is moving 4.4.1.1.2
4-993	A	50	37	50	37	Critical cost of fuel cells 100 $/kW. This seems to be a exaggerated condition. It may be appropriate for the competition with car engines, but successful competition in the field of stationary installations seems possible for considerably higher costs.	Accepted – we will modified the statement

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						(Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	
4-994	A	50	43			Replace “intermittent” with “variable”.See justification above (ch4, p 36, l 43) (Arjette Stevens, De Koepel)	Noted
4-995	A	50	43	50	44	The comment in page 38 above on forecasting is valid here as well. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Noted
4-996	A	51	14			Coal gasification is treated twice, also already on page 21/22 (Blok Kornelis, Ecofys)	Noted – we will consider to move 4.3.1.1.1
4-997	A	51	15	51	27	Although the cost of CO2 avoided is low if coal gasification is the baseline technology, it seems unbalanced to mention this advantage but not the superior thermal efficiency that can be achieved compared to a conventional rankine cycle. In addition, 'flue gas capture' is usually the terminology used for post-combustion capture. Economically advantageous capture in gasification systems is based on pre-combustion capture from a gas stream integrated in the process, not from flue gases. (Kenneth Möllersten, Swedish Energy Agency)	Noted
4-998	A	51	19	51	19	What is referred to as "clean coal" here, does it imply CCS - then be explicit. (Kenneth Möllersten, Swedish Energy Agency)	Accepted – we will modified text
4-999	A	51	19			Remove reference to 'clean coal' for above reason (Kirsten Macey, Climate Action Network Europe)	Accepted
4-1000	A	51	24	51	24	Where are they located? (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Accepted – we will add information (John Kessels)
4-1001	A	51	29	51	47	Presently the technology of micro CHP is going from small scale pilots (e.g. in the Netherlands) to large scale introduction (Japan, Osaka Gas). In an article in Applied thermal Engineering, december 2005, Peacock and Newborough investigate the impact of a micro-CHP system on domestic sector emissions in the UK. The CHP is based on a 1kW Stirling engine and delivers heat and power to individual dwellings. The CO2-savings per dwelling range from 9 to 16 %, which is very significant. This means that electricity production can move from the large scale plants to the homes of the consumers, farms, hospitals, schools, which creates an enormous potential for a decentralized energy supply. (Tineke van der Schoor, Sustainability Centre Lauwersoog/ RUG-Bedrijfskunde)	Accepted

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4-1002	A	51	29	51	47	A government scheme to promote implementation of micro-CHP would have considerable CO2-benefits and decrease the cost of a micro-CHP unit and speed up any necessare learning curves. As it is a proven and tested technology that is allready widely distributed in Japan by Osaka Gas, it should be possible to stimulate implementation in all countries where natural gas is used in domestic dwellings. (Tineke van der Schoor, Sustainability Centre Lauwersoog/ RUG-Bedrijfskunde)	Accepted
4-1003	A	51	31	51	33	Efficiency of CHP highly depends on whether actual heat demand exists or not. In Japan where climate is relatively mild, capacity of CHP to produce heat is rarely used effectively except for some cases installing it in hospitals or hotels etc. According to Japan Cogeneration Center, averaged efficiency of installed cogeneration in Japan was just about 57% in 1998. We should recognize the gap between spec and actual condition. (Shigeo Murayama, The Federation of Electric Power Companies)	Accepted
4-1004	A	51	34	51	34	Again the efficiency nonsense. page 49 line 7 reads: "Electricity is the highest value energy carrier…" So stop adding up high and low value items (H-Holger Rogner, IAEA)	Noted
4-1005	A	51	36	51	36	Just simply 'gasification'? (Kenneth Möllersten, Swedish Energy Agency)	Accepted – we will add coal and biomass issue
4-1006	A	51	43	51	43	Emissions are reduced when the air emissions of grid electricity production are also taken into account and depending on the fuels used previously for heat and electricity production. In fact, this is explicitly mentioned in lines 45-46. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Noted
4-1007	A	51	46	51	46	Fig. 4.3.2: Please indicate to which quantity the emission data in the case of cogeneration refer. To the produced electricity (I suppose not). To the sum of electricity and heat (this is not a very good quantity for this purpose, because the specific emissions of heat are naturally lower then for electricity)? Or was a heat bonus used (this is a good solution, but the bonus should be indicated)? (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accepted – we will check the data
4-1008	A	51	47	51	47	The upper limit (20MWe) seems low if industrial biomass-based CHP with emerging advanced technologies is considered (eg. BIG/CC in pulp mills and sugar mills). (Kenneth Möllersten, Swedish Energy Agency)	Accepted

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4-1009	A	51	51			Additional ref to DG role or DG policies in the EU e.g. material in: van Werven, M.J.N, and M.J.J. Scheepers, 2005, DISPOWER - The Changing Role of Energy Suppliers and Distribution System Operators in the Deployment of Distributed Generation in Liberalised Electricity Markets, ECN, report ECN-C-05-048, Petten, the Netherlands. (Ad Seebregts, Energy research Centre of the Netherlands)	Noted – reference to subsection 4.4.1.1.1
4-1010	A	52	1	52	8	You mention that DME can be made from biomass. You should also mention that Fischer-Tropsch liquids can be made from biomass as well. (Lee Lynd, Dartmouth College)	Accepted
4-1011	A	52	10	52	19	Is 'eventually' the correct word given the concern that conventional oil products for transportation may not match demand sometime in the 2020s? Mention may also be made to the often slow and inadequate responses to the EU Biofuels Directive of May, 2003 (it was only in November, 2005, that the UK's Department of Transport seemed to wake up to its existence. (Michael Jefferson, World Renewable Energy Network/Congresses)	Accepted – change ”carbon related” to ”carbon reach”, check the reference
4-1012	A	52	10	52	11	Eventually is a long time so it is not possible to disprove this statement. However, while the most immediately available alternatives for conventional oil as a source of transportation fuels are very heavy oils and tar sands. As noted on Pg. 27 of this draft, both are already being produced in large quantities. Coal, either via a gasification or liquifaction is another potential source of transportation fuels. Should hydrogen fuel cells become viable, natural gas and coal are the most likely sources of hydrogen. It is likely that the transportation sector will continue to depend on fossil fuels as its primary energy source for a long time. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Noted (ch. 10-11)
4-1013	A	52	17	52	18	Which emissions? (see also the comment made for page 42) (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Accepted – we will be more specific
4-1014	A	52	20	52	20	"Gaseous fuels include natural gas...": I suggest: "Gaseous fuels include biogas, natrural gas...". (Göran Berndes, Chalmers University of Technology)	Accepted
4-1015	A	52	21	52	21	The list of hydrogen sources is not technically correct. I suggest the following: "and hydrogen from coal, natural gas, biomass, and water, using steam reforming, gasification, conventional electrolysis, wind or solar electrolysis, biochemical methods, and/or nuclear or concentrated solar heat. (Stan Bull, National Renewable Energy Laboratory)	Accepted

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4-1016	A	52	31	52	32	Exploting methane hydrate resources is a quite problematic area that needs more than one sentence to provide a balanced description. Otherwise remove. (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-1017	A	52	41	53	15	Subsection 4.4.2.2: The perspectives of a hydrogen economy depend also on public acceptance of hydrogen use. In addition to anxiety about safety, some researchers have pointed out possible harmful influences on the environment, e.g., Tromp, T.K., R.L. Shia, M. Allen, J.M. Eiler, and Y.L. Yung, 2003: Potential Environmental Impact of a Hydrogen Economy on the Stratosphere, Science 300(5626), pp.1740-1742. (Takanobu Kosugi, Ritsumeikan University)	Accepted
4-1018	A	52	42	52	43	Emissions from H2 production is another important aspect. If emissions from production are high hydrogen can essentially be as bad or worse as the direct use of fossil fuels. (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-1019	A	52	42	52	49	What might also be of use here is the work of the European Hydrogen & Fuel Cell Technology Platform, particularly the 'Strategic Overview', at pages 11 & 12 where both the ambition and the challenges of this technology is highlighted. Goals and timeframes for market penetration are established, as well as a definition of the cost challenges (reduction in cost of fuel cells by between a factor of 10 and a factor of 100; reduction of cost of hydrogen production by a factor of 3 or more) and the need to icnrease the reliability and durability of fuel cells by a factor of two. Available at: https://www.hfpeurope.org/hfp/keydocs (Steve Sawyer, Greenpeace International)	Accepted
4-1020	A	52	0	53		It should be stated clearly that hydrogen is only as clean as the technologies producing the hydrogen. Currently of the hydrogen that is produced today comes from fossil fuels and, hence, does little to contribute to reducing emissions. Calling hydrogen intrinsically clean is as wrong as calling electricity clean. Hydrogen is an energy carrier, not a primary energy source. (Arjette Stevens, De Koepel)	Accepted
4-1021	A	53	1	53	2	Plans could easily be developed without all those prerequisites being fulfilled. The implementation of plans is another story and needs several criteria to be met. (Kenneth Möllersten, Swedish Energy Agency)	Rejected
4-1022	A	53	3	53	5	Add "However, the steam reforming of methane involves CO2 emissions thus CO2 emissions from the production needs to be taken into account in choosing a method." (Koji Kadono, Global Industrial and Social Progress Research Institute)	Rejected

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4-1023	A	53	3	53	15	This whole discussion seems to be quite simplistic and apologetic. I believe there is a need for a change of paradigm in developing a hydrogen economy and I do not see it yet (see the US National Academy of Science 2004 report "The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs"). (Marco Mazzotti, Institute of Process Engineering)	Rejected
4-1024	A	53	8	53	8	Should read: "Large hydro and nuclear (fission and/or fusion) power plants also offer promise…" (Robert Goldston, Princeton Plasma Physics Laboratory)	Rejected
4-1025	A	53	12	53	13	Solid storage (e.g. as a metal hydride)' should be changed to 'materials-based storage (e.g. as a metal hydride, a chemical hydride, a carbon-based materials)'. R&D of hydrogen storage in the form of chmical hydrides (solid or liquid) and carbon-based materials have been conducted actively. (http://www.eere.energy.gov/hydrogenandfuelcells/storage/materials.html) (Ryota OMORI, Japan Science and Technology Agency)	Noted
4-1026	A	53	13			Change to (e.g. as a metal hydrides, chemical hydrides, and carbon nanostructured materials.) (Stan Bull, National Renewable Energy Laboratory)	Noted
4-1027	A	53	14	53	15	The only reasonable (or risk minimised) method of producing hydrogen is via renewable energies from a climate protection point of view. The sentence "A number of pathways to produce hydrogen from solar energy is also feasible." gives the impression that solar energy as primary source for hydrogen production is only a minor option compared to large hydro and nuclear energy. This is under-estimation of solar energy (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Rejected
4-1028	A	53	15			Figure 4.4.6 ? Should be Fig 4.4.5 (Daniel Jansen, Energy research Institute of the Netherlands)	Noted
4-1029	A	53	17	53	17	Erratum: Figure 4.4.5 or 4.4.6? (FÉLIX HERNÁNDEZ, IEG-CSIC)	Noted
4-1030	A	53	17	53	17	Fig. 4.4.6: the number of the figure with this legend ist 4.4.5. Some paths lack in the figure. The path Solar Energy - wind - electricity should be added (although it is included in the path solar energy - electricity in an aggregated sense. But in this sense, you need only one path solar energy - hydrogen, anyway). Also a path biomass - electricity should be added. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Noted
4-1031	A	53	21	53	45	Though you mentioned solar heat in the "solar" section, you might want to also	Noted

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						mention it here since you're also including an explicit section on "heat". (Lee Lynd, Dartmouth College)	
4-1032	A	53	33	53	36	Popularity of heat pump comes not only price decline, but also from improvement in efficiency, which leads to lowering running costs. As heat pump makes use of ambient heat, the output can be more than 600% of input. (Shigeo Murayama, The Federation of Electric Power Companies)	Noted
4-1033	A	53	33	53	36	If the intention here is to present a complete overview of heat pump options, then include also the option to earth-to air and earth-to-water systems. The most common heat pump system use in Sweden is where you use a ca 100 m deep borehole. (Göran Berndes, Chalmers University of Technology)	Rejected
4-1034	A	53	38	53	44	this § develops biomass solution, but not at all geothermal solution. A few lines should be added do describe also geothermal options for heat production, either from deep reservoir, direct use of hot springs, or use of shallow groud heat through heat pumps. (VARET JACQUES, BRGM)	Accepted
4-1035	A	53	43	53	44	What is meant by 'best' in this case? Pls be more specific. (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-1036	A	53	47	53	47	This section is on production costs not mitigation costs. The headline needs to be changed. (Kenneth Möllersten, Swedish Energy Agency)	Noted
4-1037	A	53	47	58	17	There are annoying inconsistencies in the entire section 4.5 where costs are sometimes given as per Wh produced and sometimes as cost per installed W, also for PV installation cost is per W whereas for many other technologies it is per kW. (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-1038	A	53	47			In assessing the comparative mitigation costs and potentials for the various energy supply systems, it is necessary to consider whole of lifetime costs including the costs of plant-decommission, opportunity costs of the land areas involved, environmental remediation and any long lived hazardous waste stewardship. This has not been systematically done in this section and needs to be attended to for correct conclusions. (Roger Gifford, CSIRO)	Noted
4-1039	A	53	47			Section 4.5's title is Mitigation costs and potentials, but this section only discusses energy supply costs and potentials(it is similar to section 4.3.1 (Table 4.3.1). It is suggested to change the title to "Projected costs and potentials", otherwise the discussion on mitigation costs and emission reduction potentials needs to be added	Noted

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						in order to keep the original title. (Wenying Chen, Energy, Environment, and Economics Research Institue, Tsinghua Univerisity)	
4-1040	A	53	49	54	5	Is this section the appropriate place to raise differing approaches to cost comparisons or calculations for different energy sources? Noting, as above, Awerbuch; Patterson (2004) both raise issues about the basis for cost calculations across different energy sources, including fuel price, transmission costs (noting that IEA's World Energy Investment Outlook's Alternative Scenario, with its contribution of renewable energy and efficiency, lowers transmission costs by 40% and distribution costs by 36%, compared to business as usual, resulting in lower overall investment requirements even though renewable energy itself is more costly, therefore these factors need to be taken into account. This may also be relevant to clarify with respect to section 4.5.5 and Table 4.5.3., and to other areas. (Kirsty Hamilton, retainer to UK Business Council for Sustainable Energy; Associate Fellow, Chatham House.)	Noted
4-1041	A	54	16	54	16	The following wording is proposed to improve clarity: ".. due to additional energy efficiency improvement and a small increase in total renewable energy uptake compared to the business as usual scenario." (Radunsky Klaus, Umweltbundesamt)	Accepted
4-1042	A	54	20			Section 4.5 comment -- Not sure what this section adds. It provides no new information but instead rehashes information in previous sections. And it perpetuates some misleading statements commented on earlier (eg, p. 54 line 24.) Costs and resource potentials should be discussed with each technology where there is some context for the information. , and I think many of them already discuss costs and potential. I suggest making sure the technology sections discuss costs and potentials and dropping section 4.5.2. (Stan Bull, National Renewable Energy Laboratory)	Accepted
4-1043	A	54	20	55	8	The title of section 4.5.2 shoul be replaced by "Fossil fuel energy". Coal should be also mentionned. A sentence should be added to introduce carbon capture and storage, which is described from line 39 p 54. (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Rejected
4-1044	A	54	24	54	32	Could be updated the estimates for news prices per barrel? (FÉLIX HERNÁNDEZ, IEG-CSIC)	Noted
4-1045	A	54	36	54	36	€570-830 /MW or €35-70 /MW. What is the difference between this values? Is the unit of the second pair of numbers correct? (Ortwin Wolfgang Renn	Noted

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						Weimer-Jehle, Institute for Social Science, University of Stuttgart)	
4-1046	A	54	39	54	39	Introduce abbreviation in the titel: Carbon capture and storage (CCS) (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accepted
4-1047	A	54	43	54	44	The text reads, "The costs of transport and storage of CO2 could decrease slowly as the technology matures further and the scale increases (IPCC, 2005)," while this is in the IPCC SRCCS 2005, and this text is treating this issue cautiously, the availability of secure reservoirs represents the use of a limited resource and the arguments here are not appealing. Preferred rewording: "The costs of transport and storage of CO2 could decrease slowly as the technology matures further and the scale increases (IPCC, 2005), but at the same time, since the low-cost sequestration opportunities will likely prove to be finite, total costs for transport and storage may rise to negate this effect of a maturing technology base." (Richard Doctor, Argonne National Laboratory)	Noted
4-1048	A	54	46	54	46	Fig. 4.5.1: Explain abbreviations in the figure. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accepted
4-1049	A	54	46			Figures (p.375 of PDF) Table 4.5.1 Transport costs are consistent with the IPCC SRCCS, nicely done table. (Richard Doctor, Argonne National Laboratory)	Accepted
4-1050	A	54	49	54	50	Replace "saline formations" by deep saline aquifers". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted
4-1051	A	55	1	55	4	It might be useful to mention the 15-55% techno-economic potential this century estimated by the SRCCS. (Kenneth Möllersten, Swedish Energy Agency)	Rejected
4-1052	A	55	2	55	4	Such concern is not specified in the Special Report. Suggest to delete the sentence. (Koji Kadono, Global Industrial and Social Progress Research Institute)	Noted
4-1053	A	55	2	55	2	Add: "… the knowledge of deep saline aquifers is quite limited in most part of the world, due to their lack of economic interest except when in places they contain hydrocarbons. (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Rejected
4-1054	A	55	3	55	3	It is proposed to delete "and ocean storage" because according to the IPCC Special Report on Carbon Capture and Storage this option is still in the research phase and the IPCC was not in a position to assign a quantitative figure to a hypothetical mitigation potential of ocean storage and thus ocean storage seems to be of a different quality and does not qualify to be mentioned.	Noted

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						(Radunsky Klaus, Umweltbundesamt)	
4-1055	A	55	6	55	6	Table 4.5.2: replace "Saline formations" by "Deep saline aquifers". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted
4-1056	A	55	9	57	38	COMMENT: Throughout the section(4.5.3), different measures are applied to each renewable energy technology and it makes it difficult to compare between these technologies. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted
4-1057	A	55	9	57	38	Throughout the section(4.5.3), different measures are applied to each renewable energy technology and it makes it difficult to compare between these technologies. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted
4-1058	A	55	11	55	12	Remove first sentence. No need to explain the basic concept of renewable energy in this section. (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-1059	A	55	11	55	18	I do not agree with the statement that the best sites with good resources have been used. This is simply not true for wind (offshore), biomass (we are just starting) and solar (same). Any statement on investment price per kW is useless and confusing if statements on the capacity factor are missing. (Wim Sinke, Energy research Centre of the Netherlands)	Accepted
4-1060	A	55	11	55	18	I do not agree with the statement that the best sites with good resources have been used. This is simply not true for wind (offshore), biomass (we are just starting) and solar (same). Any statement on investment price per kW is useless and confusing if statements on the capacity factor are missing. (Wim Sinke, Energy research Centre of the Netherlands)	Accepted
4-1061	A	55	11	55	18	I do not agree with the statement that the best sites with good resources have been used. This is simply not true for wind (offshore), biomass (we are just starting) and solar (same). Any statement on investment price per kW is useless and confusing if statements on the capacity factor are missing. (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted
4-1062	A	55	11			page 55, 11 ff: " Typical construction costs for new power plants are high, being up to US$2500/kW for some technologies, but on good sites they can generate power for around 3-4USc/kWh (Martinot, 2005). On poorer sites the costs are very variable (Table 4.3.1). In areas where the industry is growing, many of the best sites with good resources for wind, geothermal, 15 biomass and hydro have already been utilised, so more costly projects might be predicted in the future. Conversely learning experience from the previous projects will help to drive down	Accepted

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						the development costs." This might be true for German wind sides, but is definitely NOT the case for the rest of the world! (Arjette Stevens, De Koepel)	
4-1063	A	55	11	55	18	This comment is too general. What Martinot 2005 actually says that on 'good sites' costs can be as low as 2 cts/kwh for hydro, and 3 cts/kwh for biomass, and that costs are coming down rapidly. While many of the 'good sites' for onshore wind development in some of the top ten wind power markets have been taken up in Germany, NL and the Denmark, this is patently not the case in the US, China, India, Italy & Portugal...and of the emerging markets, Australia, Brazil, Canada, France, the Philippines, Poland and Turkey, this is absolutely not the case. And this doesn't mention all the 'best' sites, which are offshore. It is true that most of the 'best sites' for large hydro have been taken up, but htat is not the case for small hydro or biomass...or geothermal for that matter. (Steve Sawyer, Greenpeace International)	Accepted
4-1064	A	55	13	55	13	But later on in the section investment cost for PV is stated to be 3600$/kW, so why is upper limit 2500? (Kenneth Möllersten, Swedish Energy Agency)	Noted
4-1065	A	55	14	55	14	Table 4.3.1: Use uniform unit for the costs, eg. $/GJ for energy sources (but c/kWh for electricity produktion). (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accepted
4-1066	A	55	15			Delete “wind”. It may be true for Denmark but replacement of older turbines with more effective new ones makes the statement wrong – good sites are getting available though decommissioning. The same tendency is seen in Schleswig-Holstein in Germany. The argument may be true for a few areas of Spain, but to make a general comment in a report covering the entire world based on a few areas of Europe is misleading. We haven’t even started exploiting the most windy sites yet. (Arjette Stevens, De Koepel)	Noted
4-1067	A	55	15	55	17	More attention to wording here- are you really saying there is little cost-effective scope for renewable energy to grow?????????? Surely we are not at saturration for anything than large-scale hydro yet? (HEDGER MERYLYN, Environment Agency)	Accepted
4-1068	A	55	15	55	16	We would strongly disagree that "many of the best sites with good resources for	Accepted

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						wind, .. Biomass … have already been utilized…." Even in the US (where the industry is growing, as noted in the text), there are vast areas as yet undeveloped in the central and northern US. The best resources for utility-scale solar (US southwest, north Africa, etc) have not yet been touched. (Stan Bull, National Renewable Energy Laboratory)	
4-1069	A	55	16			More costly, and more damaging, projects. Already, pushed by government subsidies and political goals, very tall (125 m, with taller ones envisaged) wind turbines in areas officially designated as of great landscape value (even areas of outstanding natural beauty and sites of special scientific interest) are being proposed for areas of low wind speed (eg scarcely 5 m/s at 10 m above ground level at Roughness 1 sites). (Michael Jefferson, World Renewable Energy Network/Congresses)	Noted
4-1070	A	55	18	55	18	An addition should be made to note that R&D continues to drive down costs of renewables as well as learning experience. (Stan Bull, National Renewable Energy Laboratory)	Accepted
4-1071	A	55	20	55	30	I repeat my earlier comment that these are a highly suggestive text and figure, since it is just a difficult way to show the concept and definition of capacity factor. It really serves no other purpose than to incorrectly suggest that fossil and nuclear are better than renewables and therefore I strongly object. No-one (except for Uchijama) would directly compare technologies with a capacity factor of 85-95% with those with a factor 10-20%, as is done. If definitions would have been chosen differently the figure would also be completely different. The most important parameter in the context of this report is current and future electricity generation cost, which has very little to do with the infomation in this figure. Please skip. (Wim Sinke, Energy research Centre of the Netherlands)	Noted Some editing to the figure needed. Comments 4-1072 and 4-1073 are repetitions of the same comment
4-1072	A	55	20	55	30	I repeat my earlier comment that these are a highly suggestive text and figure, since it is just a difficult way to show the concept and definition of capacity factor. It really serves no other purpose than to incorrectly suggest that fossil and nuclear are better than renewables and therefore I strongly object. No-one (except for Uchijama) would directly compare technologies with a capacity factor of 85-95% with those with a factor 10-20%, as is done. If definitions would have been chosen differently the figure would also be completely different. The most important parameter in the context of this report is current and future electricity generation cost, which has very little to do with the infomation in this figure. Please skip. (Wim Sinke, Energy research Centre of the Netherlands)	Noted
4-1073	A	55	20	55	30	I repeat my earlier comment that these are a highly suggestive text and figure, since	Noted

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						it is just a difficult way to show the concept and definition of capacity factor. It really serves no other purpose than to incorrectly suggest that fossil and nuclear are better than renewables and therefore I strongly object. No-one (except for Uchijama) would directly compare technologies with a capacity factor of 85-95% with those with a factor 10-20%, as is done. If definitions would have been chosen differently the figure would also be completely different. The most important parameter in the context of this report is current and future electricity generation cost, which has very little to do with the infomation in this figure. Please skip. (Ad Seebregts, Energy research Centre of the Netherlands)	
4-1074	A	55	22	55	23	Rephrase "The average capacity factor of PV systems in Japan is below 15%" as "For instance in a certain coutry, the average capacity of factor of PV systems is below 15%". REASON: "below 15%" is mentioned to compare the capacity factor of PV to those of other energy sources and there is no data from other countries than Japan. Therefore it is irrelevant to specify a country name. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted
4-1075	A	55	22	55	22	Quoting that the capacity factor in Japan is below 15% without explanation is misleading. The capacity factor is almost totally dependent on the amount of average daily sunlight in any geographic location, up to a maximum of near 50% in equatorial desert regions. (Stan Bull, National Renewable Energy Laboratory)	Noted
4-1076	A	55	22	55	23	Rephrase "The average capacity factor of PV systems in Japan is below 15%" as "For instance in a certain coutry, the average capacity of factor of PV systems is below 15%". REASON: "below 15%" is mentioned to compare the capacity factor of PV to those of other energy sources and there is no data from other countries than Japan. Therefore it is irrelevant to specify a country name. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Accepted
4-1077	A	55	25	55	26	If 'total output' is supposed to denote installed capacity (which would seem logical), then try to be clear about it. Output could also be energy. (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-1078	A	55	29			Figure 4.5.1. What is the unit? (Matti Melanen, Finnish Environment Institute)	Accepted
4-1079	A	55	33	55	34	The capability is a function of the costs: to which maximum costs refer the value of 60 EJ? Add: /year. (Ortwin Wolfgang Renn	Noted

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						Weimer-Jehle, Institute for Social Science, University of Stuttgart)	
4-1080	A	55	48	55	48	The low range of cost figures (i.e.1000 $/kW) is too high. Does it refer to any particular circumstances? (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Noted
4-1081	A	55	50	55	50	I wonder what the reference for the 4.5% is and whether this is true for modern turbines. (Wim Sinke, Energy research Centre of the Netherlands)	Accepted
4-1082	A	55	50	55	50	I wonder what the reference for the 4.5% is and whether this is true for modern turbines. (Wim Sinke, Energy research Centre of the Netherlands)	Accepted
4-1083	A	55	50	55	50	I wonder what the reference for the 4.5% is and whether this is true for modern turbines. (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted
4-1084	A	55	0	57		text: ADMIRE REBUS is a dynamic simulation model of the international market for renewable electricity. It pays explicit attention to trade barriers, discriminative support policies, risks, and other imperfections inherent in a market in transition (Daniëls and Uyterlinde, 2005). The model matches national supply curves (based on costs and potentials) with policy-based demand curves so as to take into account the discriminative characteristics of policies, where appropriate, and the ability of producers to choose whether they produce for the domestic market or whether they wish to trade their production. Because of the different levels of national support schemes, different submarkets emerge with local equilibrium prices. (Daniëls and Uyterlinde, 2005) describes the way in which the model simulates the policy-induced renewable electricity market, and shows results concerning the contribution of several important technologies in five scenarios that differ with regard to assumed ambition level, trade barriers, and timing of EU member states' policies on renewable electricity. Within the chosen scenarios, the model shows wind offshore to be the most sensitive technology with regard to the policy environment. (Ad Seebregts, Energy research Centre of the Netherlands)	Noted
4-1085	A	55	0	57		see above: unbalanced + outdated! (Arjette Stevens, De Koepel)	Noted – see above
4-1086	A	55	0	57		Section 4.5.3. Additional references: Daniëls, B.W. and M.A. Uyterlinde, 2005, ADMIRE-REBUS: Modeling the European market for renewable electricity,	Noted

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						Energy, Vol. 30, issue 14, November 2005. (Ad Seebregts, Energy research Centre of the Netherlands)	
4-1087	A	55	0			Section 4.5.3 Renewable Energy. The reader can only read good news and good prospect for ALL renewable forms of energy, with strikingly high estimates of potential energy use from renewable sources. I wish the authors were right. I do not have the knowledge and expertise to argue in detail here, but I feel it will be healthy for the IPCC credibility (and even for the credibility of renewable supporters) to seek a more balanced and realistic view of the prospects for renewable energy trying to explain not only the good and bright side of theoretical potentials , but also the real world, governed by a physical law that makes always more difficult (and costly) to obtain usefull energy from diluted sources. Also, discuss how the limitations in scale, increasing dispersion (as the "easy" spots to capture renewable energy are used), security of supply, and overall scalating costs to ensure continuous energy supply, may prevent/limit the large expansion of the different renewable options. In this respect, the little subsections on Hydropower and Wind are examples of good balanced text. The biomass section is the poorest. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Noted - we will review
4-1088	A	55	0	57		Additional ref. Noord, M. de; Beurskens, L.W.M.; Vries, H.J. de, 2004, Potentials and costs for renewable electricity generation : A data overview , ECN-C--03-006, ECN, Petten, The Netherlands, February 2004. http://www.ecn.nl/library/reports/2004/c03006.html (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted
4-1089	A	56	4		5	", assuming a 20% average capacity factor" Should be changed to: ", assuming a very conservative 20% average capacity factor". Justification: For 2010, we estimate an average onshore capacity factor of 24.5% and 42.5% offshore. Depending on the share of offshore, the European average would lie somewhere in between – probably 26-27% on average (Arjette Stevens, De Koepel)	Noted
4-1090	A	56	5	56	6	Try to use consistent units and not alternate between Wh and J. (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-1091	A	56	5	56	5	I got some problems with the number. Please check. 126,000 TWh are 453,6 EJ. Not double the 600 EJ potential of Johansson et al. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accepted – we will check number
4-1092	A	56	6	56	9	It should be added however that the objections of local residents are very often based on incorrect information on some wind energy impacts (e.g. impacts on	Noted

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						birds), on the lack of adequate involvement and participation of local communities during the design and operational phase of the farm etc. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	
4-1093	A	56	9			Delete “intermittent (Arjette Stevens, De Koepel)	Rejected – key to the reference
4-1094	A	56	9	56	11	This sentence should be deleted because Gul & Stenzel (2005) does not value the practical maximum amount of wind power acceptable to a grid. (Kenichi Oshima, Ritsumeikan University)	Noted – the reference will be checked
4-1095	A	56	9	56	11	Gul & Stenzel don't conclude the practical maximum amount of wind power acceptabe to a transmission. This sentence is misleading. (Masatake Uezono, Citizens' Alliance for saving the Atmosphere and the Earth)	Noted – the reference will be checked
4-1096	A	56	10	56	10	20-30 %: Contradiction to page 38, line 39 (maximum 20 %). See comments there. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accepted
4-1097	A	56	11			Delete “without expensive backup required”. Justification:1. It is simply wrong. According to several national studies – including the DENA grid study – there is no need for additional conventional plant and that extra reserve needs for wind power can be obtained from existing conventional power plants. See reference in my comment to p.36, line 43 above. 2. In the UK, the grid extension / reinforcement costs of adding 30% wind is €cents 0.47/kWh or app. 10% of total generation costs. For a technology that reduces cost by app. 3% per year, that is not significant. Furthermore, it is simply unacceptable that grid costs are only discussed in connection to wind and never to other technologies. We have studies these costs extensively, but I have never seen a study on the grid integration costs of coal, gas and nuclear. What are the grid costs of building the new nuclear reactor in Finland? I can guarantee they are extensive but nobody has asked for a calculation. The point is that wind is not more expensive in grid costs than other technologies. In fact, its distributed nature makes it cheaper in grid costs than other technologies but we can’t document it because no studies are made for other technologies. See p4 of the following slides for IEA assessment of costs : http://www.erec-renewables.org/documents/Berlin_2004/pwp/Wednesday_Session_3/Session%203/Panel%203a/Fatih_Birol.pdf . In the UK, the grid extension / reinforcement costs of adding 30% wind is €cents 0.47/kWh or app. 10% of total generation costs. For a	Noted The discussion of back-up is quite balanced; for example during peak load conditions availability of back-up is crucial. Concerning costs of grid connection costs the availability of evaluations will be checked.

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						technology that reduces cost by app. 3% per year, that is not significant. Furthermore, it is simply unacceptable that grid costs are only discussed in connection to wind and never to other technologies. We have studies these costs extensively, but I have never seen a study on the grid integration costs of coal, gas and nuclear. What are the grid costs of building the new nuclear reactor in Finland? I can guarantee they are extensive but nobody has asked for a calculation. The point is that wind is not more expensive in grid costs than other technologies. In fact, its distributed nature makes it cheaper in grid costs than other technologies but we can't document it because no studies are made for other technologies (Arjette Stevens, De Koepel)	
4-1098	A	56	13	56	44	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)	Accepted
4-1099	A	56	13	56	44	When discussing the cost potential of biomass, 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 2050 date cited in the text. See NRDC's "Growing Energy" report as a reference: http://www.nrdc.org/air/energy/biofuels/contents.asp (Lee Lynd, Dartmouth College)	Accepted – we will look at reference
4-1100	A	56	13		44	Additional reference: Gielen, D.J., Feber, M.A.P.C. de, Bos, A.J.M. and Gerlagh, T. 2001: Biomass for energy or materials ? A Western European systems engineering perspective. Energy Policy 29, pp. 291-302. (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted – we will look at reference
4-1101	A	56	14	56	43	It is unclear where the sustainable utilisation of whole trees fit in to this description of biomass potential. (Kenneth Möllersten, Swedish Energy Agency)	Noted - Ref. to ch. 9
4-1102	A	56	14	56	22	Is the whole para on residues and waste? (Kenneth Möllersten, Swedish Energy Agency)	Noted – ref. to biomass cross-cutting group
4-1103	A	56	18	56	18	"...available...": I cannot think David Hall would say 2900 EJ of potential biomass energy was available. Isn't this 2900 EJ number just an estimate of the total global productivity for a selection of ecosystem types, given in order to provide an	Accepted

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						understanding of how large the theoretical upper limit is? (Göran Berndes, Chalmers University of Technology)	
4-1104	A	56	19	56	19	"Hoogwijk (2004)...": Monique Hoogwijk did not include the study referred to here in her thesis. The correct reference (refered also to in Ch. 3 and 8) should be: Berndes, G., Hoogwijk, M. and van den Broek, R. (2003). The contribution of biomass in the future global energy supply: A review of 17 studies. Biomass and Bioenergy 25: 1-28. (Göran Berndes, Chalmers University of Technology)	Accepted
4-1105	A	56	20	56	21	This information is of little use to the reader who is not familiar with the definitions of 'research focus' and 'demand driven' potentials. (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-1106	A	56	20	56	20	"..research focus...": should be "...resource focus...". The two main categories of general approach referred to in the study is (i) demand-driven assessments that analyzed the competitiveness of biomass-based electricity and biofuels, or estimated the amount of biomass required to meet exogenous targets on climate-neutral energy supply (demand side); and (ii) resource-focused assessments that focused on the total bioenergy resource base and the competition between di0erent uses of the resources (supply side). The study illustrates what a future large-scale bioenergy supply (several hundred exajoules per year) could look like and also show that such a supply is indeed technically feasible. But it does not say how many exajoules that can be supplied at "competitive costs". Such estimates is on the other hand given in Monique Hoogwijk's thesis, which is referred to just below this text (Ch. 4, pp 56, line 25). (Göran Berndes, Chalmers University of Technology)	Accepted
4-1107	A	56	22	56	22	Is the 200-300 EJ based on the IPCC's judgement? (Kenneth Möllersten, Swedish Energy Agency)	Noted - provide the reference
4-1108	A	56	30	56	32	Fischer and Schrattenholzer (2001) = correct reference? They do not say anything about how much bioethanol or biodiesel that can be produced 2050, and they do not say anything about specific cost levels. (Göran Berndes, Chalmers University of Technology)	Noted – we will check the reference
4-1109	A	56	38	56	38	Seeing as this is a relatively new act, how can it be that it has already proven to be crucial? (Kenneth Möllersten, Swedish Energy Agency)	Accepted – the text will be modified
4-1110	A	56	45			Why aren't we pushing geothermal more, if it is really 3-8Usc/kWh? That's basically the same as wind and it is a constant power source. (Michael Bowman, GE Global Research)	Rejected - change to 2-10USc/kWh (table 4.5.3)

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4-1111	A	56	46	56	50	this § On geothermal costs is far too brief compared with other renewable sources, and should be developped, notably to distinguish the follwing cases : high enthalpy geothermal fields, low enthalpy geothermal fields, use of shallow geotherml resources and enhanced and deep geothermal system (VARET JACQUES, BRGM)	Accepted – text will me merged
4-1112	A	57	2	57	7	A potential should be given (as done for the other renewables). (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	See table 4.3.1
4-1113	A	57	9	57	13	COMMENT: The examples provided here of solar thermal equipment are a little too locally specific.Also, the costs are expressed in Euro (US$ is used in other parts). (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Noted
4-1114	A	57	9	57	13	The examples provided here of solar thermal equipment are a little too locally specific.Also, the costs are expressed in Euro (US$ is used in other parts). (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Noted
4-1115	A	57	16	57	26	What about thin-film solar cells? These two paras seem to deal with monocrystalline modules. (Kenneth Möllersten, Swedish Energy Agency)	Noted – text will be merged 4.3
4-1116	A	57	16	57	20	One has to distinguish between modules only and complete turn-key systems. Efficiency is hardly relevant here. The relevant numbers for both, as a function of time, may be taken from http://europa.eu.int/comm/research/energy/pdf/vision-report-final.pdf: "A Vision for Photovoltaic Technology", final report of the European PV Technology Research Advisory Council, report nr. EUR 21242 (2005), starting document for the European PV Technology Platform. I consider the used references less relevant in this context and certainly outdated . At least a more recent reference as given should be included. Typical 2005 figures (from the reference) "are: 5 euro/Wp turn-key system, corresponding to 0.25-0.65 euro per kWh (depending on location). In 2020 these are expected to be reduced to 2 euro/Wp (0.10-0.25 euro/kWh), in 2030 to 1 euro/Wp (0.05-0.07 euro/kWh). After that a further decrease is expected. (Wim Sinke, Energy research Centre of the Netherlands)	Accepted – text will be merged 4.3
4-1117	A	57	16	57	20	For comparison, it would be helpful to provide information for other locations than high sunshine, eg central Europe. (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-1118	A	57	16	57	18	On p.57, at lines 16-18 the Report states: "Electricity generated directly by utilizing solar photons to create free electrons in a PV cell is estimated to have a technical	Noted – we will check

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						potential [emphasis added] of at least 1600 EJ per year". There are two problems here: (a) What does "technical potential" mean? In Table 4.3.1, the 1600 EJ/yr figure is listed in the column labeled "estimated available energy resource". Then in Table 4.5.3, we find under the column labeled "technical potential up to 2050 (EJ)" that the technical potential of Solar PV and Solar Thermal combined is 80,000 EJ. Some clarification of the meaning of terms is required. (b) The 1600 EJ/yr estimate, to say nothing of the 80,000 EJ estimate is meaningless, for all practical purposes. To see why let us turn back to p.45 of Chapter 4 where at lines 49-50, the Report says that: "The average annual solar insolation varies with latitude ranging from between 1000 kWh/m^2 in temperate regions to 2500 kWh/m^2 in dry desert areas. Let us generously assume that the solar panels are placed in areas where the annual insolation averages 2000 kWhm^2. Further, let us assume the conversion efficiency is 15% and that spacing of large arrays of panels requires that the area be doubled to avoid shading when panels are tilted toward the sun, and to allow servicing, including the huge task of keeping the panels clean from dirt, grit, etc. By my calculation, each EJ/yr of energy would require a panel area of 920 km^2, doubled to 1840 km^2 to meet the spacing requirement. This means that 1600 EJ/yr would require dedicated land area of 2,944,000 km^2-or 2.3 % of the land surface of the earth, not including the polar icecaps. (Christopher Green, McGill University)	
4-1119	A	57	16	57	20	One has to distinguish between modules only and complete turn-key systems. Efficiency is hardly relevant here. The relevant numbers for both, as a function of time, may be taken from http://europa.eu.int/comm/research/energy/pdf/vision-report-final.pdf: "A Vision for Photovoltaic Technology", final report of the European PV Technology Research Advisory Council, report nr. EUR 21242 (2005), starting document for the European PV Technology Platform. I consider the used references less relevant in this context and certainly outdated . At least a more recent reference as given should be included. Typical 2005 figures (from the reference) "are: 5 euro/Wp turn-key system, corresponding to 0.25-0.65 euro per kWh (depending on location). In 2020 these are expected to be reduced to 2 euro/Wp (0.10-0.25 euro/kWh), in 2030 to 1 euro/Wp (0.05-0.07 euro/kWh). After that a further decrease is expected. (Wim Sinke, Energy research Centre of the Netherlands)	Accepted
4-1120	A	57	16	57	20	One has to distinguish between modules only and complete turn-key systems. Efficiency is hardly relevant here. The relevant numbers for both, as a function of time, may be taken from http://europa.eu.int/comm/research/energy/pdf/vision-	Accepted

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						report-final.pdf: "A Vision for Photovoltaic Technology", final report of the European PV Technology Research Advisory Council, report nr. EUR 21242 (2005), starting document for the European PV Technology Platform. I consider the used references less relevant in this context and certainly outdated . At least a more recent reference as given should be included. Typical 2005 figures (from the reference) "are: 5 euro/Wp turn-key system, corresponding to 0.25-0.65 euro per kWh (depending on location). In 2020 these are expected to be reduced to 2 euro/Wp (0.10-0.25 euro/kWh), in 2030 to 1 euro/Wp (0.05-0.07 euro/kWh). After that a further decrease is expected. (Ad Seebregts, Energy research Centre of the Netherlands)	
4-1121	A	57	19			2004 module costs in a variety of different countries can be obtained from the IEA Photovoltaic Power Systems Program (www.iea-pvps.org) and range from $3.25/Wp to $19.6/Wp. There may be 2005 data available before the AR4 is finalized. (Danny Harvey, University of Toronto)	Accepted – we will take a look
4-1122	A	57	20	57	20	There is a later, 2005 version of the U.S. Climate Change Technology Program information; see www.climatetechnology.gov. This may be useful for all references to the 2003 documents. (Stan Bull, National Renewable Energy Laboratory)	Accepted – we will apply to whole report
4-1123	A	57	22	57	22	For what reason was 27% chosen? (Kenneth Möllersten, Swedish Energy Agency)	Accepted
4-1124	A	57	24	57	25	will be' makes it sound as an absolute certainty but it's based on a prediction. (Kenneth Möllersten, Swedish Energy Agency)	Rejected
4-1125	A	57	25	57	26	COMMENT: "by 2040 over 20% of global electricity demand": This is merely an estimate by one piece of the literature and not a general prospective. Not sufficient to conclude the explanation of PV. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Noted – we will find other literature
4-1126	A	57	25	57	26	"by 2040 over 20% of global electricity demand": This is merely an estimate by one piece of the literature and not a general prospective. Not sufficient to conclude the explanation of PV. (MASAHIRO NISHIO, Ministry of Economy, Trade and Industry)	Noted – we will find other literature
4-1127	A	57	26			Additional ref. On solar PV and learning curve, EC sponsored research project PHOTEX: Schaeffer, G.J.; Seebregts, A.J.; Beurskens, L.W.M.; Moor, H.H.C. de (ECN, Petten (Netherlands)); Alsema, E.A. (Utrecht University); Sark, W. (Utrecht University); Durstewicz, M. (ISET); Perrin, M. (GENEC); Boulanger, P. (GENEC); Laukamp, H. (Fraunhofer); Zuccaro, C. (CESI), Learning from the Sun;	Accepted

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						Analysis of the use of experience curves for energy policy purposes: The case of photovoltaic power. Final report of the Photex project, ECN-C--04-035 (August 2004), Petten, the Netherlands (Ad Seebregts, Energy research Centre of the Netherlands)	
4-1128	A	57	34	57	38	There is - rather surprisingly - no mention here of the severely adverse environmental impacts that would follow harnessing of marine currents in either the Bay of Fundy or Solway Firth. The Bay of Fundy's two most technically interesting sites are the Cumberland and Minas basins. Estuarine barrages at either or both sites would have catastrophic impacts on species such as the semi-palmated sandpiper. On the Solway Firth, in common with other potential sites for estuarine developments, severely adverse impacts would be felt by migratory and over-wintering birds. Only developments that would permit tidal mud flats and their associated invertebrate populations to remain accessible would avoid such catastrophe. (Michael Jefferson, World Renewable Energy Network/Congresses)	Rejected – we are talking about potentials
4-1129	A	57	41	57	41	There should be subsections here under Nuclear for Fission and Fusion, just as there are subsections under Renewables for Hydro, Wind, Biomass etc. (Robert Goldston, Princeton Plasma Physics Laboratory)	Rejected – too detailed
4-1130	A	57	41			4.5.4 Nuclear Fusion: The U.S. , EU and Japan have each undertaken studies to determine the economic, environmental and safety aspects of nuclear fusion. Fusion can be used to produce electricity, and also - perhaps in larger scale facilities - hydrogen at off-peak hours. The estimated cost of electricity from fusion is in the range of $US 0.05 to $US 0.10 per kWh(e). Fusion has a very large resource base, 300,000 EJ in known lithium deposits and an essentially unlimited resource of lithium in sea water. Fusion is also a steady energy source whose location is not constrained by the need for renewable energy flows or acceptable geological formations for carbon sequestration. High political stability is not necessarily a limiting requirement, which might considered a requirement for nuclear fission power. As a consequence of these factors, fusion is not limited in the fraction of the world's energy it can supply due to resources, intermittency (which limits the ultimate fraction of penetration), geography or political stability. Thus its ultimate potential to mitigate CO2 emission is very high, particularly when the need arrives for a very large fraction of non-CO2-emitting power. Upon successful demonstration of fusion power production, commercialization of fusion is contemplated to begin in about 2050. With a reasonable penetration rate, fusion primary power production could reach over 200 EJ per year in 2100. By 2150	Noted The reliability of cost data for fusion is not as good as the data for existing energy forms (NPPs, coal, gas etc). Separately the theoretical estimate for fusion energy could be mentioned in case a good reference can be found for citation.

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						fusion could provide a large fraction of the world's non-carbon-emitting energy needs. It is important to recognize that the longer-term challenges for CO2 mitigation dwarf those in the nearer term. Almost independent of the choice of energy use and equilibrium CO2 scenario, it will be necessary to provide non-CO2-emitting power in the range of 500 EJ/year by 2100 and over 1000 EJ/year during the next century, while 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 large-scale non-CO2-emitting energy resources that, in aggregate, are not limited in their fractional market penetration. (Robert Goldston, Princeton Plasma Physics Laboratory)	
4-1131	A	57	41	58	17	It is necessary to refer to the argument on economical efficiency of nuclear power. (Masatake Uezono, Citizens' Alliance for saving the Atmosphere and the Earth)	Noted
4-1132	A	57	42			• P. 57. Section 4.5.4. It should be specified whether the cost comparison presented encompasses all costs (i.e. waste treatment, plant decommissioning or any other relevant pollution cost) or whether the figures correspond to the production cost only. I find this section too short and not sufficiently comprehensive on the economic advantages and disadvantages of nuclear power generation. Countries such as Germany, Belgium, UK, Sweden, Finland, USA have taken opposite decisions on this issue, an assessment of the insights from economic analysis on the issue would be greatly informative and remind the reader on how much economic assessments can diverge on this issue when a comprehensive analysis of the nuclear production cycle is taken into account. (Philippe Tulkens, TERI School of Advanced Studies)	Taken into account Nuclear waste management, disposal and decommissioning costs have been taken into account in the reviewed cost studies.
4-1133	A	57	45		46	The cost references to nuclear are the short term marginal production costs, not the total costs, i.e. it only reflects the operating costs. On page 55, line 50, wind power costs are long-term marginal costs of 3-4 cents. The operating costs of wind power is €cents 1.2-1.5 / kWh (see http://www.ewea.org/fileadmin/ewea_documents/documents/projects/rexpansion/050531_Economics.pdf), which is lower than the $cents 1.7 quoted for nuclear. The point is that it is not serious to quote operating costs for nuclear and total costs for wind and other technologies. (Arjette Stevens, De Koepel)	Taken into account The point refers to existing plants. Anyway, the back-end costs (waste management and disposal and decommissioning costs are included as well for existing plants. All cost items (not only operating costs) have been included for the power plant types compared in the OECD study.
4-1134	A	58	12	58	17	RECOMMENDATION: Deletion of the final paragraph of section 4.5.4 (lines 12 to 17). JUSTIFICATION: The text states that the economic competitiveness of different energy production forms is dependent on "local conditions." However, the subsequent text only discusses the example of the higher decomissioning costs for	Noted Will be clarified and refer to plant-specific differences.

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						Magnox nuclear reactors compared to light water reactors. The cost difference is due to differences in the two technologies, not local conditions. The lower cost for decommission light water reactors would apply had they been built instead of the Magnox nuclear reactors. The text only illustrates that the more modern light water reactor has improved economics with regards decommissioning costs than the older Magnox design. Furthermore the text does not quantify the impact on economic competitiveness in terms of the overall generation costs of these differences in decommissioning costs. (Jonathan Cobb, World Nuclear Association)	
4-1135	A	58	16		17	full life cycle costs: applies not only to nuclear fuel cycle. Also other options (Res, fossil) and inclusion of externalities (Ad Seebregts, Energy research Centre of the Netherlands)	Noted It is clear that same requirement applies to other energy forms as well.
4-1136	A	58	18	58	18	A subsection should be inserted describing the mitigation costs and potentials for fusion. A proposed such subsection is provided as an attachment labeled "Fusion Mitigation.doc" (Robert Goldston, Princeton Plasma Physics Laboratory)	Rejected This section includes cost comparison for existing plants only.
4-1137	A	58	19	58	50	Seen the title of section 4.5, the reader would expect in this section and in table 4.5.3 an overview of mitigation options and potentials. However, the table is on potentials for energy generation, which is probably useful in section 4.2.3, but not here, where a table summarising 4.3, 4.4 and 4.5 is needed. (Peter Bosch, IPCC TSU WGIII)	Agree – being compiled
4-1138	A	58	21	58	22	Add also a reference to the ExternE, an important research project funded by the European Commission in the nineties, which compared different modes of electricity supply based on life-cycle analysis and including environmental externalities. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Taken into account The reference could be added. However, the estimation of external costs related to climate change and other long-tem impacts includes large uncertainties.
4-1139	A	58	27	58	27	"from gas to coal" should be "from coal to gas"? (Matti Melanen, Finnish Environment Institute)	Accept
4-1140	A	58	28	58	28	switching from coal to gas, not from gas to coal. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Accept
4-1141	A	58	28	58	30	How do you get reductions from switching from gas to coal? Did you mean switching from coal to gas? Or does this assume switching from gas without CCS to coal IGCC with CCS? Please clarify. Others studies have shown that solar	Accept. All included

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						photovoltaics, geothermal, combined heat and power, and fuel cells using renewable fuels could also pontentially play a significant role in reducing emissions. Please include. (Steve Clemmer, Union of Concerned Scientists)	
4-1142	A	58	38			Available resource is not the issue. The question is when they peak and prices go through the roof. (Arjette Stevens, De Koepel)	Covered in Oil section
4-1143	A	58	45	58	47	If left as such, the sentence should be: " … properly valued AND REFLECTED IN THE MARKET PRICE in order to …" (line 46) (Peter Wittoeck, Belgian Federal Administration)	Being rewritten
4-1144	A	58	49	58	49	Table 4.5.3: Energy resource nuclear is only fission. Complete Energy resource for solar thermal and biofuels (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Noted Nuclear will be specified to mean nuclear fission power The comment related to solar and biofuels is unclear
4-1145	A	58	49			Table 4.5.3 The figures of technical potential of nuclear up to 2050 are based on fallacious assumptions, as is discussed in comments of this reviewer on page 33 and 34. (Jan Willem Storm van Leeuwen, Ceedata Consulting)	Taken into account See responses to specific comments for pages 33 and 34
4-1146	A	58	49	58	49	Table 4.5.3 should include a column "Technical potential up to 2200" since climate change is a much longer-term problem than just the next 50 years. It should then also include a row for fusion. The reality illustrated by the analysis of Wigley, Richels and Edmonds, and similar analyses provided for example on pages 223-224 of the TAR Climate Change 2001, The Scientific Basis, is that the problem is much longer term than 50 years. Furthermore, the problem is 10x larger in the long term (~50,000 EJ / 50 years) than in the short term (~5000 EJ / 50 years). In effect, we need to introduce technologies in the present century that can almost fully replace carbon-emitting technologies in the next century. Thus we need to be advancing new energy technologies with very high total potential, and we have to be moving to energy uses that are consistent with very low CO2 emission. While it is important to pay attention to the near term, this report must absolutely also keep the much larger long term challenge in focus. See the attached analysis of future non-carbon energy needs, labeled "WRE Analysis.pdf". (Robert Goldston, Princeton Plasma Physics Laboratory)	Being considered – BOB
4-1147	A	58	49	58	49	Table 4.5.3: COMMENT C The same comment as comment 2 just above applies to the comparison of	Accepted Bob

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						potentials. (Peter Wittoeck, Belgian Federal Administration)	
4-1148	A	58	49	58	49	Table 4.5.3: COMMENT B A detailed list of what is included in the measure of the costs is necessary because some elements can make a significant difference on the final figures. For instance, it should be mentioned whether subsidies and R&D expenditures are accounted for, whether the costs of the treatment of nuclear waste is included, etc. The sentence from page 57 line 50 to page 58 line 1 does not give enough information. Moreover, it is stated on page 62 lines 4-6 that accurate cost comparisons between technologies are hard to make (due to the difficulty to include subsidies in the measurement). Therefore, we strongly recommend to add a general discussion on why cost evaluations and, consequently, cost comparisons, are difficult to make. Such a general discussion should take place in section 4.5.5. (Peter Wittoeck, Belgian Federal Administration)	Taken into account The list of items included can be completed. For nuclear fuel cycle, for example, all cost items are included. The same requirement applies for section 4.5.5 for other energy forms.
4-1149	A	58	49	58	49	Table 4.5.3: COMMENT A The range given for consumer costs is significantly different from the one given in the TAR (see page 256 of IPCC TAR). For instance, in the case of nuclear energy, the range is 1-10 c/kWh in the FOD AR4, compared to 3.9-8.0 in TAR (i.e., a decrease if one looks at the mean of each range) and, in the case of wind energy, the range is 4-8 c/kWh in the FOD AR4 compared to 3.0-8.0 in TAR (i.e., an increase). Of course, the change in the absolute values may depend on the monetary unit (year) or other such variables. But it is particularly surprising to observe that the cost (at least as measured by the mean of the given range) for nuclear energy decrease while the cost of wind energy increases, given that the learning curve for renewable energies – wind in particular—is very steep. This comment certainly deserves an explanation. A clear comparison with the TAR findings is also highly recommended. (Peter Wittoeck, Belgian Federal Administration)	Noted The cost information (cost intervals) will be checked and references given.
4-1150	A	58	49			Table 4.5.3. Energy supply potentials are fine, but are'nt we more interested in GHG mitigation potentials? (Blok Kornelis, Ecofys)	Agree. Covered
4-1151	A	58	0			Section 4.5.5 This should be the core of the chapter. One of the main (and most sensitive) pieces of information for a policy maker. How much does it cost and how much carbon can I avoid with a given option?. Only half a page of poor, superficial text ?. It is essential to support the Table 4.5.3 with a more solid discussion on the sources of information, their underlying assumptions.... space cannot be an excuse	Agree. Been modified as such

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						to keep this section so small¡¡. There is plenty of space available reducing the size of the following sections. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	
4-1152	A	58	0	58		We do not see the purpose of section 4.5.5. The title seems to suggest that its goal is to evaluate which technologies will be implemented in the future. We also believe that this is a crucial issue that deserves much attention. Since only 'private' (production or consumption) costs are presented in the table, the issue to be dealt with in the section is well which are and will be the most 'competitive' technologies. However, the section goes one step further and seems to analyse how policies will or should impact on the development of the technologies. Again, we are convinced that it is the next crucial issue to be analysed. Nevertheless, in this case, one must look not only at the private costs, but also at the costs of the externalites caused by the alternative technologies (as suggested on lines 45-47 !). These external costs include (i) the climate damages (or, equivalently, external benefits should include avoided climate damages) and all the other externalities such as (ii) those mentioned in section 4.7.3 (co-benefits, i.e, reduced air pollution, employment effets, etc.) and (iii) the risks. (On the risks, see a comment below.) (Peter Wittoeck, Belgian Federal Administration)	Leads on to GHG mitigation. Agree – authors will note. Is being amended to this effect – but references needed.
4-1153	A	59	3	81	12	Sections 4.6 and 4.7 are also very confusing. What is called the "risk section"(4.6) is actually an integral part of the policy context ("the political economy"of the energy sector) in which policy instruments have to function (and therefore this belongs in 4.7). This connection should be shown, because it could explain why certain instrument work and others not (the material on country experiences also needs to be integrated in the overall analysis, because shows very nicely the strenths and weaknesses. The reader at the end should be able to draw conclusion on whatn works (under what circumstances) and what does not work and what it costs. More material on country experiences from putting in place Kyoto policies should be used (dig into national communications under UNFCCC for instance). (Bert Metz, IPCC)	Accepted, action take.
4-1154	A	59	5	59	5	The following title is proposed: Risks for baseline technologies (Radunsky Klaus, Umweltbundesamt)	Accepted
4-1155	A	59	10			While one could, I guess, include this under the first bullet, there is a significant risk of failure with new technologies simply because they are not "proven" technologies. This risk may be more significant than whether or not it meets performance objectives. It takes time (or at least long term testing) to establish a technology as "tried and true".	Accepted, bullet text changed.

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						(John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	
4-1156	A	59	10	59	19	Another risk factor: social risks. Social developments can lead to the loss of acceptance for energy conversion systems and projects. (Ortwin Wolfgang Renn Weimer-Jehle, Institute for Social Science, University of Stuttgart)	Acepted, new bullet inserted.
4-1157	A	59	21		30	CIEP, 2004 may be interesting reference (see earlier comment) (Ad Seebregts, Energy research Centre of the Netherlands)	Noted
4-1158	A	59	32	59	41	It should be noted that until now no liberalized energy market could prove that it can guarentee energy supply security in the long term. (Radunsky Klaus, Umweltbundesamt)	Noted
4-1159	A	59	37			UCTE (www.ucte.org) use indicators to ensure sufficient system adequacy (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted, text changed.
4-1160	A	59	0			Section 4.6.1. This is quite a heavy piece of text that could be reduced to a couple of paragraphs. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted, text is being reduced.
4-1161	A	59	0	60		Risks. This section would be better linked to the rest of the chapter by considering (most of) these risks as external costs. Indeed, human health risks as a consequence of noise, emissions, etc…, ecological and environmental risks from effects on species and ecosystems, etc… fall clearly in the category of external costs (or, possibly, benefits). Most other risks mentioned on page 59 fall in the category of private costs. Note that risks can really be considered as costs since they may be measured by the damage cost times the probability of occurrence of the event (see for instance Gollier (2001) - Ch. Gollier (2001), The economics of risk and time, MIT Press, June 2001, 450 p.) PLEASE SEE THE REST OF THE COMMENT IN COMMENT 19 (Peter Wittoeck, Belgian Federal Administration)	Rejected, self evidnent.
4-1162	A	59	0	60		COMMENT 18 Continued - Moreover, the risks falling in the 'external costs' category must also include those associated with specific technologies. For instance, the risks of nuclear proliferation, accidents and terrorism must also be mentioned and the methodologies to assess these risks should be discussed (risk aversion, discounting, etc.). As an illustration of the potential importance of these risks, please note that the MIT report (MIT (2003), The future of nuclear energy: a interdisciplinary study, MIT; by the way, this reference is not yet in the FOD!) concludes that "Nuclear power should not expand unless the risk of proliferation from operation of the commercial nuclear fuel cycle is made acceptably small" (see	Noted, chapter restructured.

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						p.12). Finally, on the basis of this comment, as well as the previous above comment over section 4.5.5, we recommend to merge and to give a clear structure to the information currently given in sections 4.5.5, 4.6, 4.7.3 and 4.7.4. (Peter Wittoeck, Belgian Federal Administration)	
4-1163	A	59	0	60		This section 4.6 on risks is conceptually interesting, it could usefuly also cite work on relative risk and portfolio diversity, including in relation to renewbles (Awerbuch, S. and M. Berger (2003). "Applying Portfolio Theory to EU Electricity Planning and Policy Making." International Energy Agency - Energy Publications 03) and diversity (Stirling, A. (1998). "On the economics and analysis of diversity." SPRU Electronic Working Paper No 28 - also in Energy Policy) including of low carbon systems (Grubb, M., L. Butler, et al. "Diversity and security in UK electricity generation: The influence of low-carbon objectives." Energy Policy In Press, Corrected Proof downloadable from http://www.econ.cam.ac.uk/faculty/grubb/publications.html) (Michael Grubb, Cambridge University)	Noted.
4-1164	A	60	13	60	42	This passage seems to have been written by someone who has not taken on board fully the issues discussed, inter alia, on page 25 of the chapter (eg Hall, Hallock). Caution must be expressed about assuming global trade in conventional oil will double by 2030, quite apart from what could well be happening through the 2030s. Unconventional oil will offer some substitution for conventional oil, at a cost and with a more limited resource base. The idea that this will be some sort of 'seamless web' transition ('largely invisible') does not seem 'more likely'. Instead, perceptions of demand likely to exceed supply will probably precede both that imbalance for conventional oil and major uptake of non-conventional oil as well as a falling away of total oil production (ie by the early 2020s). (Michael Jefferson, World Renewable Energy Network/Congresses)	Accepted: “trade” replaced by “consumption”.
4-1165	A	60	13			Surely this projected doubling does not take account of any arrangements set in place to curtail GHG emmisions from fossil fuel burning. As that is the topic that this dcoument addrresses some further words are needed to link this sentnece to the subject of the document. (Roger Gifford, CSIRO)	Rejected: Citing reference material.
4-1166	A	60	21	60	22	The scientific evidence that price volatility "has resulted from unpredictable shifts in OPEC's production policy..." is missing. If the described causal connection is really existing and can be proved, this has to be thoroughly supplied with sources from literature.	Accept

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						(Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	
4-1167	A	60	21			"Price volatility, particularly in oil, has resulted…." Should be replaced by: "Price volatility, particularly in oil and gas, has resulted…." Justification: The gas price follows the oil price and is just as volatile. (Arjette Stevens, De Koepel)	Accepted: The word "gas" inserted.
4-1168	A	60	21	60	21	Price volatility of natural gas should also be noted. (Stan Bull, National Renewable Energy Laboratory)	Accepted.
4-1169	A	60	27	60	28	The internalization of environmental externalities in market prices will result in prices that correctkly reflect all costs involved and therefore will aid people making more-informed and therefore better decisions on energy services. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Rejected, no connection i n text found.
4-1170	A	60	42			Substitution dynamics of a switch from conventional to unconventional fuels is not addressed. Therefore please insert the following: "However, there is doubt that switching from conventional fossil fuels to unconventional and renewable fuels can be accomplished smoothly without structural breaks leading to disruptions of supply. Options like tar sands, liquefied coal and others have to be thoroughly assessed, including various criteria like total amount that can be made available in short, medium and long term perspective, public acceptance, energy demand of production and others." (Nikolaus Supersberger, Wuppertal Institute for Climate Environment and Energy)	Accepted, text amended in another section.
4-1171	A	61	1	62	9	What is section 4.6.2 really about? The headline 'Mitigation options' gives no guidance, mitigation options has already been dealt with in previous sections, and it seems to have no clear theme. (Kenneth Möllersten, Swedish Energy Agency)	Accepted, this section merged with section 4.5
4-1172	A	61	1	62	8	Lacks mitigation potential & costs by technology - table would be useful here (Francisco de la Chesnaye, USEPA)	Accepted, figure will be inserted in section 4.5
4-1173	A	61	1	61	23	The quotation from Michael Grub gives the impression that emission trading will fail to deliver because of lack of price sginal and investment. It is more correct to say that it is too early to assess the impact of emission trading in providing a price signal and the environmental delivery and economic competativeness. It is true that for the time being some particualr ruels could lead to some future inconsitencies but more balanced information is needed, e.g. on the price impacts of coal based power generation... Underlying economic theory/assumptions for projections (of C-markets and prices) should be scrutinized; this is in particular a topic for Ch. 13.	Noted, part of this this section covered by Ch. 13 and part of it merged with section 4.5

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						The implications of ET for the Energy sector should be discussed in Ch. 4 though." The following literature should be examined (all IEA papers) - Emissions Trading and its Possible Impacts on Investment Decisions in the Power Sector (Julia Reinaud); Industrial Competitiveness Under the European Union Emissions Trading Scheme (Julia Reinaud); Emissions Trading - Taking Stock and Looking Forward (Reinaud and Philibert); IETA Greenhouse Gas Market Report 2005 " the Rubber hits the Road; (Andrei Marcu, IETA)	
4-1174	A	61	2	61	2	The following title is proposed: Risks for mitigation options (Radunsky Klaus, Umweltbundesamt)	Accepted, action take.
4-1175	A	61	4			I'm confused by this statement. Do you mean the increased costs of energy extracting technologies will cause energy prices to rise? But we note that actually, while the technologies advance and are more expensive at least initially, the trend is that it costs less and less to extract fossil fuels. The same can be said for electricty production; it used to be that marginal costs declined as electricity production plants increased in size but that is no longer so. See Huber and Mills, "The Bottomless Well" or Jaccard, "Sustainable Fossil Fuels". Do you mean that costs of new more efficient demand technologies raise the cost of energy? But, because they are more efficient, they would have a damping effect on energy prices. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Rejected, sentence self evident
4-1176	A	61	4	61	23	COMMENT: The text on emissions trading should be rewritten to take into account the experience gained in the initial year of operation of the scheme. (Jonathan Cobb, World Nuclear Association)	Accepted, bullet text changed.
4-1177	A	61	6	61	6	What does 'this' refer to, what is being planned? Energy price rises? Try to be clear! (Kenneth Möllersten, Swedish Energy Agency)	Acepted, new bullet inserted.
4-1178	A	61	7	61	9	It sounds as though cap-and-trade systems would primarily create market conditions that discourage investmens in renewables. This is far too negative. (Kenneth Möllersten, Swedish Energy Agency)	Noted
4-1179	A	61	7	61	9	The reference used to support the argument is relatively old. To date, the EU-ETS is in full operation, as well as the CDM (where the number of projects is continuously growing). Consequently, the carbon market has progressed significantly since 2003 and the picture on carbon prices is now more clear (although uncertainties still exist). Provide info on conlusions drawn by recent relevant scientific work.	Noted

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						(ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	
4-1180	A	61	7	61	9	The sentence of the draft, which seems supported by a paper quotation, gives however the impression that the system which is implemented step by step at regional and international level, will fail because lack of price signal for appropriate investment. I think it is too soon to make such an affirmation. It is true (see my previous comments) that for the time being some particular rules could lead to some future inconsistencies, but I woudl suggest to balance the statement in another way : "The international trading of carbon is new and if appropriate harmonised rules are not set up on the mid term, the latter could result in ....." (Jean-Yves CANEILL, Electricité de France)	Accepted, text changed.
4-1181	A	61	7	61	9	RECOMMENDATION: Rewrite text to read: "However, unpredictable prices for carbon allowances over the medium to long term could discourage the desired level of investment in zero or low greenhouse gas emitting technologies." JUSTIFICATION: The current reference (Grubb, 2003) refers to widely fluctuating prices over the medium to long term. It is not clear that prices will fluctuate widely. However, it remains true that uncertainty over carbon prices in the medium to long term, may mean emissions trading is ineffective in promoting zero or low greenhouse gas emitting technologies, if those technologies require long term price certainty to stimulate investment. This point is true whether carbon prices fluctuate widely or not. (Jonathan Cobb, World Nuclear Association)	Accepted, text is being reduced.
4-1182	A	61	9	61	10	Insert: To overcome CO2-price uncertainties in case of economic recession it is proposed to apply performance standards with annual adjustment of a Compliance Factor for future years, to encourage innovation and efficiency improvement. This gives predictability for investors to reduce emissions (Schyns, 2005 d, pp 53, see page 45). Schyns 2005 d = "Options and consequences for the allocation of allowances to electricity producers", December 21, 2005, paper presented at the European Chemical Regions Network (ECRN) meeting on 21-22 December 2005 in Maastricht. (Vianney Schyns, DSM & SABIC)	Rejected, self evidnent.
4-1183	A	61	11	61	12	This behaviour (initially higher than expected prices) is typical in cap-and-trade systems, as in the beginning traders are not fully informed on all aspects of the carbon market. It happened also in the US with the Acid Rain Programme. However, after a while, prices decrease and the market reaches stability. In EU-	Noted – also for Chap 12.

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						ETS, carbon price has dropped from more than 25 Euros/t CO2 to approximately 20 Euros / t CO2 to date. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	
4-1184	A	61	13	61	14	RECOMMENDATION: Delete "This type of scheme acts to bring benefits to industries producing or using carbon-neutral energy forms." and replace with "The EU ETS brings benefits to companies that can reduce greenhouse gas emission at a cost below the trading price of carbon. However, it may not benefit those industries already producing or using carbon-neutral energy forms as those industries do not benefit from the free allocation of emissions allowances given to existing emitters." JUSTIFICATION: It is not the main purpose of the EU ETS to act to bring benefits to industries producing or using carbon-neutral energy forms. Its purpose is to achieve the reduction the emissions of existing emitters of greenhouse gases cost-effectively. At present participants in the scheme, such as operators of a fossil fuel power station, receive a large percentage of the emissions allowances they require through free allocation, whereas operators of nuclear or renewable generation do not receive allowances. The scheme therefore does not fully internalise the cost of carbon emissions. (Jonathan Cobb, World Nuclear Association)	Noted The suggestions will be considered in redrafting
4-1185	A	61	16			Important to distinguish between cost introduced into the system, and prices. The effect on production costs and prices have to be treated as separate issues. The statement, as it is, seems misleading. Also confusing that trading systems are treated several places. (Oren Kjell, Norsk Hydro ASA)	Accepted, this paragraph deleted, topic covered by ch. 13
4-1186	A	61	20	61	23	What is said in this sentence may be true under some circumstances but probably not in all conditions. If imports are coming from a country which is itself capped, and if this situation leads to constraints to the electricity sector, imports are not an opportunity for leakages. In many cases, the fact that electricity can be exchanged cross boarders, may lead to environmental benefits. This has been discussed in published analysis (cf. for instance IEA : IEA Information Paper - Electricity Trade, the Kyoto Protocol and Emissions Trading, R. Baron et al. International Energy Agency, October 1998). I am suggesting to be more explicit and describe more precisely the conditions upon which what is said may happen, because the statement could give the impression that exchanges of electricity between countries is leading to inappropriate environmental outcomes, which is not the case in all	Relevant, this paragraph deleted, topic covered by ch. 13

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						circumstances. (Jean-Yves CANEILL, Electricité de France)	
4-1187	A	61	24			Add. Reference: Sijm, J.P.M., Bakker, S.J.A., Chen, Y., Harmsen, H.W., Lise, W. (2005): CO2-price dynamics: The implication of EU emission trading for the price of electricity, ECN-C--05-081, ECN, Petten, september 2005 (Ad Seebregts, Energy research Centre of the Netherlands)	Reference noted. this paragraph deleted, topic covered by ch. 13
4-1188	A	61	25	61	25	'Geosequestration' is yet another term used for the same thing in this chapter. Previously 'sequestration' and 'storage' have been used. It would be better to try to stick with one, than to introduce a third term. (Kenneth Möllersten, Swedish Energy Agency)	Accepted, paragraph merged with section 4.5
4-1189	A	61	25	61	25	Replace "Geosequestration" by "Geological storage" or "Capture and storage". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Accepted, paragraph merged with section 4.5
4-1190	A	61	31	61	37	Emergency response strategies and mechanisms can play an important part where there are political or technical reasons for supply disruption, but not where there is a fundamental imbalance between supply and demand as is projected for conventional oil. (Michael Jefferson, World Renewable Energy Network/Congresses)	Noted, paragraph moved to section 4.3
4-1191	A	61	31	61	31	Insert: For a number of reasons (needed economic benefits, monitoring and verification, etc. see page 32-33) Cozijnsen (2005) proposes that emissions trading is an ideal vehicle to enable carbon capture and storage (CCS). However, he shows that current definitions of the EU ETS are unclear (are plants with CCS participating with the scheme?) and that allocation rules are counterproductive (pages 34-38). Revision is clearly necessary and Cozijnsen proposes to make use of a benchmark (just below EU average, an amount of CO2/MWh). Also Schyns (2005 d, page 26) demonstrates that current allocation rules of the EU ETS fail for CCS as the quantity of allowances is related to historic emissions for incumbents (zero for CCS) and because allowances for new entrants are virtually always restricted to what is planned as emission (zero for CCS). (Vianney Schyns, DSM & SABIC)	Noted, subject to section 4.3
4-1192	A	61	39	61	49	Delete this paragraph. This chapter is about mitigation of climate change, not the impacts of the climate change on the insurance industry. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted, section move to 4.3
4-1193	A	61	46	61	49	Consequences of 2005 huricanes etc should be available. (Michael Jefferson, World Renewable Energy Network/Congresses)	Accepted, paragraph deleted, covered by IPCC WG II
4-1194	A	61	47	61	50	these data of course need to be updated to include 2004 and 2005 data (when available)	Accepted, paragraph deleted, covered by IPCC WG II

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						(Danny Harvey, University of Toronto)	
4-1195	A	61	0	62		Section 4.6.2. Mitigation refers to mitigation of risk not to mitigation of climate change. May be confusing to some readers. (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted, paragraph deleted, covered by IPCC WG II
4-1196	A	61	0			Section 4.6.2. Mitigation options. What is this doing here? Isn´t all we have been discussing about mitigation options?. Text is poor and unfortunate in places (in the first paragraph why pointing Sweden, Norway and New Zealand?, isn´t the international trading of carbon a tool to encourage (and not "discourage") investment in zero emitting technologies?, do not use the word Geosequestration for CCS ¡ , has the last paragraph about insurance losses anything to do with mitigation?, and finally and again: is fossil energy more subisdised than renewables?. Delete the whole section except a couple of bits that can move to 4.7 (because they belong there ¡). (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Fully accepted, this section will be rewritten and moved.
4-1197	A	61	0	61		The use of terminology 'clean coal' should be removed from this assessment report. There may be some practical measures that can be implemented to reduce the CO2 pollution from burning coal in coal-fired power stations, however, it is misleading to suggest that coal is clean as pollution is still produced. Coal fired power stations are one of the major sources of airborne mercury pollution and still produce a number of other pollutants, therefore it is highly misleading to suggest that this technology can be clean. (Kirsten Macey, Climate Action Network Europe)	Noted, but “clean coal” is an accepted termonology.
4-1198	A	62	1			You list global subsidies for fossil fuel and nuclear energy but neglect to inform the reader of the taxes on these forms of energy, especially fossil fuels like gasoline. I think it would be more appropriate to list a net amount. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Noted In some countries, e.g. in Sweden, there are special extra energy taxes for nuclear energy as well. Accepte, this paragraph will be covered by scetion 4.7 when it is updated to cover policies and instrument for energy supply.
4-1199	A	62	6	52	8	Should read "Nuclear fission power probably suffers most from public concerns about safety, waste and proliferation, and the risk to the capital markets that there will not be a viable return on investment. Nuclear fusion power suffers from the concern that investment in its development does not provide an assured date for deployment." (Robert Goldston, Princeton Plasma Physics Laboratory)	Noted The text can be more specific; i.e. refer to nuclear fission energy. Accepte, this paragraph will be covered by scetion 4.7 when it is updated to cover policies and instrument for energy supply.
4-1200	A	62	15			While you list mandated targets and the like under regulations, you might elaborate	Accepted, change in table 4.7.1.

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						a bit more on the market shaping potential of policies like renewabel portfolio standards, vehicle emission standards, permit systems and the like. The definition here sounds like you are referring only to command and control avenues when many sector specific, market oriented regulations may have far greater influence and be less "command and control" in nature. I would also include this notion in the accompanying table, Table 4.7.1. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	
4-1201	A	62	15	80	20	More attention needs to be given in this section to political economy issues and attitudes to energy policy options. (HEDGER MERYLYN, Environment Agency)	Noted, this will be addressed in the rewriting of the chapter.
4-1202	A	62	40	62	42	There is no massive emissions trading scheme in Japan, except for a small scale and trial one in which only negligible number of installations have participated in pursuit of subsidies for renewal of equipments. (Shigeo Murayama, The Federation of Electric Power Companies)	Emission trading now covered in Ch. 13
4-1203	A	62	40	62	41	To my knowledge, we don't have voluntary trading permit system operation in Norway, but we have a similar pilot system as EU, regulated by the government. (Oren Kjell, Norsk Hydro ASA)	Emission trading now covered in Ch. 13
4-1204	A	62	0			Section 4.7 I wonder if this discussion belongs to Chapter 4 or it belongs to other chapters. It is very heavy and wordy text, full of trivial statements at times, followed by quick focus on individual points and papers not too relevant to the scope fo the Chapter. If mantained in chapter 4, it should be reduced to 5-6 pages at most. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Accepted, the chapter is being rewritted.
4-1205	A	62	0	80		section 4.7 should review and clarify at outset its relationship to equivalent sections in the sectoral chapters, and in particular to Chapter 13. (Michael Grubb, Cambridge University)	Accepted
4-1206	A	62	0	66		In the policy section lots of examples are given, but not much attention is paid to the effectiveness (and cost-effectiveness of policies). For instance, the EU debate on feed-in versus obligations is completely missed. I can provide more information. See also the special issue of Energy Policy Vol. 34, issue 3. (Blok Kornelis, Ecofys)	Accepted, this will be addressed in the rewriting.
4-1207	A	63	4			Regarding Table 4.7.1, it is not clear in this table that what “Fiscal incentive” in the row of “Energy source switching” means. (Kenichi Oshima, Ritsumeikan University)	Rejected, “fiscal incentive” is established terminology.
4-1208	A	63	4			Regarding Table 4.7.1, “Subsidy reform” should be added in the cell of “Economic	Noted

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						instrument" of the row of "Energy source switching". The reason is that conventional sources of energy including coal, oil, gas and nuclear are heavily subsidized. See Cees van Beers and Andre de Moor (2001), Public Subsidies and Policy Failure, Edward Elgar. (Kenichi Oshima, Ritsumeikan University)	The statement is not (any more) equally relevant as regards nuclear energy for all cases and all countries. For example, the new plant in Finland does not receive any public financing support. covered by "fiscal incentives
4-1209	A	63	4			Regarding Table 4.7.1, "Renewable energy certificate" is a subset of quota obligation scheme or renewable portfolio standard scheme. Therefore, "Renewable energy certificate" should be altered to "Quota obligation". (Kenichi Oshima, Ritsumeikan University)	Accepted, text changed in table 4.7.1
4-1210	A	63	10			As in comment 12 above, you need to inform the reader that, while subsidies do exist, so do taxes that would reduce demand. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Accepted, will be included (Xiliang)
4-1211	A	63	10	63	27	It would be instructive to speculate on the impact of a switch in subsidy policy to $250B of which 3% was to fossil fuel and 97% to renewables. And to indciate why governments do not adopta transition to such a policy. (Roger Gifford, CSIRO)	Rejected, no literature found
4-1212	A	63	10	63	19	Suggest also 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 (Steve Sawyer, Greenpeace International)	Noted, reference will be looked at (Inga)
4-1213	A	63	10	65	22	Maybe the EC DG TREN study FORRES (sept 2005), using the EEG Green-X model gives interesting additional information on the effectiveness of different policies in EU, feed-in tarriff most effective. (Monique Hoogwijk, Ecofys)	Noted, reference will be looked at (Inga)
4-1214	A	63	28	64	5	I would suggest adding the following sentence: In the US, twenty states and the District of Columbia have adopted renewable electricity standards that could result in the development of over 29,000 MW of new renewable energy capacity in the US by 2017 and reduce CO2 emissions by 70 million metric tons (Source: Union of Concerned Scientists, Renewable Energy at Work in the States, 2005, online at: http://www.ucsusa.org/clean_energy/clean_energy_policies/res-at-work-in-the-states.html) (Steve Clemmer, Union of Concerned Scientists)	Accepted, reference will be included (Inga).

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4-1215	A	63	39	64	5	There is no mention of the failure to meet some renewable energy targets already (eg UK's 5% electricity generation from renewables by 2003) nor the unrealistic nature of numerous targets for 2010 and beyond. A simple glance at Eurostat data demonstrates the very slow increase in EU-15 and EU-25 % electricity from renewables since 1990 (in several countries there has been backward movement). For example EU-15 1990 share 13.4%; 2003 13.7%. EU-25 12.2% in 1990; 12.8% in 2003 (Eurostat). Thus the reference to EU moving from 14% in 1997 to 22% in 2010 stretches credulity to breaking point. (Michael Jefferson, World Renewable Energy Network/Congresses)	Accepted, the difficulties in reaching the targets in some countries will be included (Inga)
4-1216	A	63	39	64	5	It is proposed to add the following wording: However, until now those instruments have not been used to that extent that a sustainable energy system will result in a foreseeable future. (Radunsky Klaus, Umweltbundesamt)	Accepted. Some text will be added (Inga)
4-1217	A	63	0			Section 4.7.1.1 It is for me a great surprise to see here several strong references supporting the notion that subsidies support fossil fuels against renewables. If this is true, this is very very policy relevant information. Therefore, it is very important that the next draft contains a more detail description of the underlying metodology and assumoptions to reach these very important figures on subsidies. (Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	Noted: Coal subsidies not common today.
4-1218	A	64	1	64	5	A Finance Sector statement to the Multi-Stakeholder Dialogue process at the Bonn (Renewables, 2004) conference, summarised the characteristics of effective policy for stimulating investment as being 'loud, long and legal'. 'Loud' meaning that incentives or other instruments need to clearly designed to impact returns and attract capital;'long' meaning stable and sustained over a material timeperiod, and 'legal' meaning legally binding goals or instruments - to create confidence that policy frameworks will not change due to politics (refer Hamilton, 2005 in The Finance of Climate Change). (Kirsty Hamilton, retainer to UK Business Council for Sustainable Energy; Associate Fellow, Chatham House.)	Noted: Reference will be look at (Inga)
4-1219	A	64	5	66		Policy The overall paper is in favor of certificates and quotas for RE - but fails to deliver a prove that those mechanisms will actually work for RE. Up to now, the experience is that the majority of the RE market development is due to feed-in tariffs. Trade able certificates are currently not a driver for RE - and it´s more the questionable if this will ever be the case for RE. See the references below that support our conclusion	Accepted, text will be modified (Inga)

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						that quota/certificates currently are not efficient and effective. See page 64, 26ff - no examples given ! page 66, 5ff is a contradiction to the former chapter on page 64 onwards. See my earlier reference to the evaluation of support systems of the European Commission, Dec. 2005 and EREF/World Watch Institute 2005: http://www.eref-europe.org/downloads/pdf/2005/erefwwfinal.pdf and ECN e.a. 2005:review of international experience with renewable energy obligationsupport mechanisms: http://www.ecn.nl/docs/library/report/2005/c05025.pdf (Arjette Stevens, De Koepel)	
4-1220	A	64	7	64	39	A major review carried out by institutes in Belgium, Austria, Denmark, Germany, Sweden and the UK, supported by the European Commission concluded that on the basis of experience to date, feed-in tariffs are far superior to other mechanisms currently being used for the promotion and growth of renewable energy and the industries that support them, and there is no evidence that tradeable certificates have worked at all yet, although it is early days. See ReXpansion, "Support Schemes for Renewable Energy: A Comparative Analysis of Payment Mechanisms in the EU" at http://www.ewea.org/index.php?id=45 (Steve Sawyer, Greenpeace International)	Accepted, text will be modified (Inga)
4-1221	A	64	9			Reference must be made to the Commissions latest assessment of support mechanisms - COM(2005) 627 final. See: http://europa.eu.int/comm/energy/res/biomass_action_plan/doc/2005_12_07_comm_biomass_electricity_en.pdf. (Arjette Stevens, De Koepel)	Accepted, reference will be looked at (Inga)
4-1222	A	64	9	64	9	The following journal artical which deals with the comparison of different support schemes for renewables in electricity use could be added: Haas, R., .. et al. (2004): How to promote renewable energy systems successfully and effectively. Communication. Energy Policy 32 (6): 833-839. (Joachim Schleich, Fraunhofer Institute Systems and Innovation Research)	Noted, reference will be looked at (Inga)
4-1223	A	64	9			The literature quoted should include the results from the very important European study which analysed and compared the experience in the EU member states. Preliminary results were published in Haas, R. et al. (2004): How to promote renewable energy systems successfully and effectively. Energy Policy 32 (6): 833-839. The official and final report is published as: Ragwitz, M.; Schleich, J.; Huber, C.; Resch, G.; Faber, T.; Voogt, M.; Cleijne, H.; Bodo, P. (2004): Analysis of the	Noted, references will be looked at (Inga)

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						renewable energy's evolution up to 2020, FORRES 2020, IRB Publisher, Stuttgart, ISBN 3-8167-6893-8. Other important articles which deal with this issue are: Mitchell, C.; Connor, P. (2004): Renewable energy policy in the UK, in: Energy Policy Vol. 32, pp. 1935-1947. Meyer, N. I. (2004): Development of Danish wind power market, in: Energy & Environment, Vol. 15, No. 4, pp. 657-673. Walz, R. (2006): The role of regulation for sustainable infrastructure innovations: the case of wind energy, International Journal of Public Policy, Vol. 2, No.1. Ragwitz, M.; Huber, C.; Rech, G. (2006): Promotion of renewable energy sources - effects on innovation, International Journal of Public Policy, Vol. 2, No.1. Jacobsson, S.; Lauber, V. (2006): The politics and policy of energy system transformation - explaining the German diffusion of renewable energy technology. Energy Policy 34 (2). (Rainer Walz, Fraunhofer Institute Systems and Innovation Research)	
4-1224	A	64	11			"… exceeded €1 billion (EEA, 2004)." add: "… exceeded €1 billion, while total support to oil, gas, coal and nuclear was almost €24 billion (EEA, 2004)." Ref: EEA 2004, "Energy subsidies in the European Union" page 14 (Arjette Stevens, De Koepel)	Noted Subdivision among energy forms would be recommendable. irrelevant
4-1225	A	64	11	64	11	Is possible to add Spain among countries with feed-in tariffs? This tariff has been very important for the development of renewables here. (FÉLIX HERNÁNDEZ, IEG-CSIC)	Accepted, text will be modified (Inga)
4-1226	A	64	11	64	25	It is not necessarily true that feed-in tariff is more expensive than quantity-based approach in the real world. Menateal et al 2004(3) just describes an ideal and theoretical argument on renewable promotion schemes. Other empirical scientific researches show that feed-in tariff scheme is more efficient than quantity-based scheme. Therefore, line from 12 to 14 and 22 to 25 should be deleted. See M. Ragwitz, G. Resch, T. Faber and C. Huber (2005), Monitoring and evaluation of policy instruments to support renewable electricity in EU Member States, Institute Systems and Innovation Research. (Kenichi Oshima, Ritsumeikan University)	
4-1227	A	64	17	64	22	We strongly disagree with these statements. We do not believe that "much better results have been obtained with price based than quota based systems." First, many price-based systems such as the feed-in laws in Germany and Denmark, have been in place much longer than most quota based systems. Second, if appropriately designed, with clear rules, strong enforcement provisions and mechanisms to facilitate long-term contracts for renewable energy, quota based systems can	Noted, text will be modified (Inga)

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						provide stable long-term markets for investors and facilitate long-term power purchase agreements with utilities. Third, they can stimulate competition amoung renewable energy developers and technologies that can drive down prices and result in lower costs than price based systems. Under a quota based system the market sets the price. Under a price based system, the prices are typically set by the government and may be set either too high (generating windfall profits) or too low (resulting in no development). (Steve Clemmer, Union of Concerned Scientists)	
4-1228	A	64	17	64	22	Continued from the previous comment. Examples of successful quota based systems or renewable standards in the US include Texas, Minnesota, Iowa, Wisconsin, New Mexico, and New York. In fact, about 75 percent of the wind development installed in the U.S between 1998 and 2004 occurred in states with renewable standards. For more information see: Union of Concerned Scientists, Renewable Energy at Work in the States, 2005, online at: http://www.ucsusa.org/clean_energy/clean_energy_policies/res-at-work-in-the-states.html) (Steve Clemmer, Union of Concerned Scientists)	Noted, text will be modified (Inga)
4-1229	A	64	20		22	"The discrepancy can be explained by the higher feed-in tariffs and the stronger incentive effect of guaranteed prices". Should be replaced by:"The discrepancy can be explained by the higher certainty of current feed-in tariff schemes and the stronger incentive effect of guaranteed prices" . Justification: It is directly wrong to state that the feed-in tariffs are higher than the quota systems as clearly demonstrated by the European Commission's communication from 7 December 2005 - COM(2005) 627 final – see reference above. This evaluation demonstrates clearly that quota systems at the moment are less efficient and effective than feed-in tariffs. (because i.a. of greater investment security) (Arjette Stevens, De Koepel)	Noted, text will be modified (Inga)
4-1230	A	64	24	64	25	"Menanteau et al 2004" should be altered to "Menateau et al 2003". (Kenichi Oshima, Ritsumeikan University)	Accepted
4-1231	A	64	27	64	31	For a quantitative assessment concerning the effects of certificate trading systems it may be useful to refer to the fourth Swedish National Communication to the UNFCCC (or the Report on Demonstrable Progress) (Kenneth Möllersten, Swedish Energy Agency)	Rejected
4-1232	A	64	34	64	39	If the primary objective is reduced GHG emissions energy efficiency might as well decrease as an indirect effect. For example, is CCS becomes a preferred option (eg if the predicted 55% share upper potential predicted by the SRCCS) this would	Rejected, not relevant for this section.

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						significantly reduce overall energy efficiency. (Kenneth Möllersten, Swedish Energy Agency)	
4-1233	A	64	45	64	45	'More likely' than what? (Kenneth Möllersten, Swedish Energy Agency)	Accepted, "more deleted".
4-1234	A	65	8	65	8	In the U.S. government incentives for deployment of new energy technologies are equal in overall magnitude to government R&D investments in new energy sources and conservation. I believe that this is similar in Europe. 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. (Robert Goldston, Princeton Plasma Physics Laboratory)	Noted, literature will be looked for (Joergen)
4-1235	A	65	47			Apart from developed counties, the section should mention also the experiences (if any) in some developing countries as well. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Noted, literature will be looked for (Clive)
4-1236	A	65	49	66	4	The claim that wind power supplied about 19% of Danish electricity consumption in 2003" is simply untrue. What is true is that wind power accounted for about 19% of Denmark's total electricity production in 2003. However, due to the exports of elecricity mentioned earlier only about 4% of Denmark's electricity consumption came from wind power in 2003! [Sharman, in 'Civil Engineering', 2005]. This experience suggests that the potential for wind power in other countries is less than commonly assumed for technical reasons - eg scarcely 40% of that commonly claimed for the UK. It also suggests that there are additional reasons for the reduction in investments to those cited in Johansson and Turkenburg. (Michael Jefferson, World Renewable Energy Network/Congresses)	Accepted, "consumption" will be changed to "production"
4-1237	A	66	6			Despite Germany's strong performance in wind energy (now an installed capacity of some 16 GW), it is worth recalling that its load factor averages only about 15% (RWE 16%; E.ON 12%), and the Deutsche Energie Agentur (national grid) only allows 6% of capacity to wind energy developments when calculating the amount of electricity generating capacity available to customers. Much of the wastage occurs during the summer in Germany, whereas in Denmark much of the 'wastage' (ie exports) occurs in the winter. (Michael Jefferson, World Renewable Energy Network/Congresses)	Rejected, these details are irrelevant
4-1238	A	66	7		8	"(exceeding 13.5 GW in 2003 being nearly 40% of global…." Replace with: "(exceeding 16.5 GW in 2004 being more than 35% of global…." Reference:	Accepted, data will be updated (Inga)

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						http://www2.ewea.org/documents/EWEA_2004Map_v2.pdf. Global electricity generation 2002: 16,074 TWh (IEA 2004). Global electricity generation 2030: 31,657 TWh (IEA 2004). (Arjette Stevens, De Koepel)	
4-1239	A	66	7	66	8	Germany's installed capacity at the end of 2004 was 16,649 MW (GWEC/Greenpeace 2005) (Steve Sawyer, Greenpeace International)	Accepted, data will be updated (Inga)
4-1240	A	66	32			(Michael Jefferson, World Renewable Energy Network/Congresses)	Comment not understood
4-1241	A	66	35			above cont. / subsidies are encouraged into locations where wind speeds are in high Class 1/low Class 2 regimes. Even at 80 metres hub height these offer wind power of only around 200 W/m2. [probably refers to line 1 on this page. Seems to link with Jeffersons comment onb ch4 p38 line30.TSU] (Michael Jefferson, World Renewable Energy Network/Congresses)	Comment not understood
4-1242	A	66	47	67	6	In the case of Japan, the electric utility industry have purchased surplus power from customer's photovoltaic and wind power generation equipment, in principal at the same price as electric utility industry's electricity charges. In addition, we have purchased power from wind power generation facilities for business use, as the volume of purchased power is increasing every year. These facts have played a extreamly important role, the development of Japanese's PV and wind industry.. (Shinichi Nakakuki, Tokyo Electric Power Company)	Accepted, "wind" will be added.
4-1243	A	67	5			Some programs of rural electrification promoted by governments are keeping the same consumption (kWh/p.c)per capita for 5-10 years, but in general the access was improved, it seems to me an inadecuate assignation of scarcely resources. (Ramiro Juan Trujillo Blanco, National Programme on Climate Changes)	Rejected, no reference provided.
4-1244	A	67	6	67	6	It should be checked whether the reference should be to IEA instead of IAE. (Radunsky Klaus, Umweltbundesamt)	Accepted, IAE has been changed to IEA
4-1245	A	67	11			I think this is the crux of the problem. How much can the cost of energy rise w/o adversely affecting development and poverty in developing countries? Along the same lines, how much can the cost of energy rise in developed countries w/o experiencing global recession? Someone must have done a cost/benefit analysis. It would be great if we could say that "in order to achieve GHG objectives we are willing to incur a cost increase of x%/year of energy" acknowledging that there is a limit to what should be spent. (Michael Bowman, GE Global Research)	Rejected, however we agree that energy access is important.
4-1246	A	67	15			proper English is "correlated with", not "correlated to". More importantly, however, is that the overall correlation is not very important or interesting. What IS important	Accepted: "to" is replaced with "with". Text will moderated to show decoupling

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						are the LOW cases, where high levels of well-being are associated with unusually low energy use for those levels of well being. By just mentioning the correlation rather than the interesting exceptions on the low side, you leave the impression that energy use must be increased in order to increase well being. (Danny Harvey, University of Toronto)	between energy use and standard of living (Joergen)
4-1247	A	67	20			Poverty alleviation in general lines depends on the energy consumption per capita and the payment capacity. (Ramiro Juan Trujillo Blanco, National Programme on Climate Changes)	Rejected, the existing text is more comprehensive.
4-1248	A	67	30			At the end of this paragraph may be is neccesary add "….and donors will continue to be necessary with an integral focus considering the energy is a factor for the productive development in the perspective to generate jobs an enlarge the consumption and the payment capacity, prioritarily in areas of productive potential that offer comparative and competitive advantages. (Ramiro Juan Trujillo Blanco, National Programme on Climate Changes)	Rejected, does not add any value.
4-1249	A	67	40	67	43	It seems necessary to back the statement "Because there will be four to five times …." by a reference to literature. Independent from such reference it is strongly recommended to delete the last part of this statement "and the breeding of international terrorists the worst". This is because it is clearly beyond the scope of this report to discuss what drives terrorism and how to mitigate terrorism. (Radunsky Klaus, Umweltbundesamt)	Accepted, text modified.
4-1250	A	68	22			You neglect to deal with rebound effects. Consumers may buy more energy-demanding technolgies because they have more money now or perhaps because they feel so good about saving energy due to the purchase of a device that is more efficient than what the previous one was. They may feel justified when they replace their compact car with an SUV because the SUV is a hybrid and the compact car was not. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Accepted, paragraph deleted, old references.
4-1251	A	68	25			In developing countries people wants skilled job oportunities in urban areas and in rural areas job opportunities to improve the standart of life (access to energy services) (Ramiro Juan Trujillo Blanco, National Programme on Climate Changes)	Noted, the paragraph has been deleted.
4-1252	A	68	44			The developing world may also feel that, given their desire to improve their overall situation, they would rather develop and construct their own "leapfrogging" technologies than import them. This might be an all together separate point from the one defined at line 44.	Rejected, does not add value.

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						(John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	
4-1253	A	69	3	69	3	I'm confused by the reference to 4.4.2.2 - it refers to the hydrogen, nuclear and hydro section. My understanding is that countries like China are trying to bring traditional renewables (wind and solar) to the off-grid rural communities. (Casey Delhotal, USEPA)	Accepted, reference to 4.4.2.2. removed and text will be added (Xiliang).
4-1254	A	69	15	69	20	Given the computer/IT revolution could high dependence on paper be seen as a step that could be leap-frogged in LDC by electronic communicatioins? (Roger Gifford, CSIRO)	Accepted
4-1255	A	70	9	76		Chapter 11 (11.8.2-11.8.4 starting on p.56) , as the summarizing chapter is the most logical place to discuss this issue extensively, with chapter 4-10 concentrating on (preferably quantified) co-benefits of specific measures in the sector. The text in ch4 has little overlap, though the text here is very long and can be shortened by bringing out the essentials of the many examples and cases. Add reference to ch 11. (Peter Bosch, IPCC TSU WGIII)	Rejected, chapter will be reduced (Clive)
4-1256	A	70	23			Change recent year with last decades. Air quality regulation were widespread in 1980-1990 in USA and Europe. (Stefano Caserini, Politecnico di Milano)	Accepted
4-1257	A	70	26			Change "devastating" with "important": for PM, health effects are linked, and not so different, to NO2 or SO2 or CO health effects (i.e. see the results of the APHEA2 project…) (Stefano Caserini, Politecnico di Milano)	Accepted
4-1258	A	70	28	70	33	Comment + figure "Substitution of traditional fuels for in favor of LPG, Kerosene or biogas could have significant co-benefits in the form of lower pollution levels in households and lower GHG emissions. The arrow in the figure XXX illustrates a shift from crop residues to LPG, Kerosene or biogas wich would decreaseindoor air pollution by approximately 95% and GHG emissions by 75% (Smith, Zhang et al. 2000). Reference: Smith, K. R., J. Zhang, et al. (2000) "Greenhouse implications of household fuels: An analysis for India." Annual Review of Energy and Environment 25: 741-763 (Johanna Wickstrom, World LP Gas Association)	Accepted, references will be looked at (Clive)
4-1259	A	70	35			It seems strange that this paragraph do not have a reference to the work done by the World Health Organisation to estimate the impact of indoor air pollution on human health: 1.6 million premature deaths annually on a world basis. This is given later in the chapter. Maybe delete the paragraph here. (Kristin Aunan, CICERO Center for International Climate and Environmental	Noted, reference will be checked (Clive)

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						Research-Oslo)	
4-1260	A	70	36	70	44	Adding a figure and comment: "According to Smith, Zang et al the best comparison of stove emissions is by measuring the energy absorbed by a cooking pot which includes correction for the energy efficiency of different fuel/stove combinations. Figure XXX compares the Global Warming Commitment (GWC) of solid and gaseous household fuels burned in typical stoves in India. The measurements were carried out in the 1990s" Figure text "Global Warming Commitment per MJ energy delivered to the cooking pot: Kyoto GHGs only. " Reference: Smith, K. R., J. Zhang, et al. (2000) "Greenhouse implications of household fuels: An analysis for India." Annual Review of Energy and Environment 25: 741-763 Alternatively, there's another graph that includes a widened definition of GHGs. Title of graph "Global Warming Commitment per 1 GJ of energy delivered to a cooking pot." Reference: This figure was first published in 'Energy for Sustainable Development', Bond, T., Venkataraman, C., Masera, O., 2004, (Johanna Wickstrom, World LP Gas Association)	Noted, reference will be checked (Clive)
4-1261	A	70	50	70	51	Add: whereas EU standard for PM10 is 40 ug/m3 (European Council Directive 99/30/EC) (Stefano Caserini, Politecnico di Milano)	Accepted, change will be made (Clive)
4-1262	A	71	1			Clarify if this levels are indoor or outdoor; Clarify if this levels are usual air quality level in that areas or (probably) are hot-spot in particular conditions. Reference should be added. (Stefano Caserini, Politecnico di Milano)	Accepted, "indoor" added
4-1263	A	71	10	71	40	(Kristin Aunan, CICERO Center for International Climate and Environmental Research-Oslo)	Ununderstandable comment
4-1264	A	71	17			insert "that" after "showed" (Danny Harvey, University of Toronto)	Accepted.
4-1265	A	71	36			Also in developed countries, the use of biomass for residential heating purpose is a significant source of emissions of PM and NMVOCs. Research conducted at a local scale (Caserini et al., 2005a) or a more wider scale AEAT (2004) confirm a significant use of biomass in household in Europe, with a consistent impact on PM10 level in air (Caserini et al., 2005b). (Stefano Caserini, Politecnico di Milano)	Noted, will be checked (Clive)
4-1266	A	71	36			Add: Also in developed countries, one of the most important point of conflict between air quality and GW policies is the use of biomass for house heating	Accepted.

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						purposes. (Stefano Caserini, Politecnico di Milano)	
4-1267	A	71	48	71	50	give examples of specific conflicts (I am not convinced that there are any that cannot be avoided). I think that this is a false dilemma. (Danny Harvey, University of Toronto)	Rejected
4-1268	A	72	2	72	20	While it is true that the impacts of climate change may be larger than the impacts of acidification, the relatively miniscule increase in global CO2 emissions caused by scrubber operations is more than justified by the reduction in the impacts of acidification. The trade-off here is a very small increase in CO2 emission for total control of sulfur emissions. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Rejected
4-1269	A	72	10	72	11	specify how much energy is needed (as a fraction of gross electricity output). What about IGCC- it achieves low emissions and greater efficiency than conventional powerplants (Danny Harvey, University of Toronto)	Rejected
4-1270	A	72	19	72	20	This tradeoff exists only if one insists on an outdated "end-of-pipe" approach to pollution control. If, instead, one pushes energy efficiency, alternatives to coal, or IGCC, then both CO2 emissions and SO2 emissions are reduced at the same time. Thus, it is largely a false dilemma. (Danny Harvey, University of Toronto)	Noted, will reference energy efficiency versus end-of-pipe(Clive)
4-1271	A	72	36			What does a section on dematerialization do in the chapter on Energy Supply? I would say it belongs in the chapter Industry. (Blok Kornelis, Ecofys)	Accepted, section removed
4-1272	A	72	38			I do not think this definition is right. Also replacement with a 'lighter' version of the product, extended lifetime etc. can lead to dematerialisation. I would define dematerialization as the reduction of material throughput per unit of human activity (in the broadest definition per unit of GDP). (Blok Kornelis, Ecofys)	Section deleted.
4-1273	A	72	43	72	43	Adding "or replacing currency money by plastic money"? (FÉLIX HERNÁNDEZ, IEG-CSIC)	Section deleted
4-1274	A	73	2			there is no such thing as sustainable economic growth (Danny Harvey, University of Toronto)	Section deleted
4-1275	A	73	7	73	10	how about figuring out what the point is that you want to make, and stating it in plain, simple, and clear English. (Danny Harvey, University of Toronto)	Section deleted
4-1276	A	73	20	74	15	This paragraph on cobenefit of mitigation policies would strongly benefit from	Accepted, will be coordinated with Ch. 11

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						linking to Chapter 11.8 (page 56 and onwards). Here in Chapter 4 very few relevant references to work within the field are given. If they are not going to be included here, a reference to further details in Ch 11.8 should be given. (Kristin Aunan, CICERO Center for International Climate and Environmental Research-Oslo)	(Clive)
4-1277	A	73	40			Here it is stated that health benefits typically constitute the largest share of co-benefits. However, this may to some extent and in some regions be due to lack of proper data and methods for evaluating ohter benefits. For instance, the study by O'Connor et al (2003) in China indicates a 50/50 share between health benefits and avoided crop loss due to surface ozone reductions.See: O'Connor, D., F. Zhai, Kristin Aunan, Terje Berntsen and Haakon Vennemo, 2003. Agricultural and human health impacts of climate policy in China: A geneal equilibrium analysis with special reference to Guangdong. Technical Paper Series No 206, March 2003. OECD Development Centre. Paris, France. 85pp. (Kristin Aunan, CICERO Center for International Climate and Environmental Research-Oslo)	Accepted, text will be modified (Clive)
4-1278	A	73	43			An exception is the OECD study referred above. Including agricultural effects in a better way than previous studies it finds that half of ancillary benefits relates to agriculture. (Haakon Vennemo, ECON)	Accepted, text will be modified (Clive)
4-1279	A	73	44	73	44	One co-benefits study that focused on the energy sector found substantial health benefits could be attained through a number alternative energy generation scenarios in Buenos Aires, Argentina. Although it is not a refereed journal article, I recommend citing the study report. Citation: Gaoli, Fabian, Pablo Tarela, Anna Sorensson, Elizabeth Perone, and Mariana Conte Grand. 2002. "Valuation of human health effects and environmental benefits of greenhouse gas mitigation and local air pollution abatement option in Buenos Aires metropolitan area." Final Integrated Environmental Strategies report. Available at: http://www.epa.gov/ies/argentinadocs.htm (Mark Heil, U.S. Environmental Protection Agency)	Noted, will be considered (Clive)
4-1280	A	73	0			The paragraph on co-benefits (or possible 4.7.4.6 where CDM is mentioned) could include a reference to an assessment of domestic benefits from exploiting China's energy related CDM potential (by some accounts home to half of the world's CDM potential): Vennemo et al. (2005) synthesize a significant body of recent research on co-benefits of climate abatement in China and estimate that between 34 and 161 lives are saved for each million ton of CO2 reduced in China. This implies between	Rejected, to general for chapter 4.

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						3,000 and 40,000 saved lives annually associated with the total CDM-potential. Additional gains related to reduced damage to agricultural crops and materials were estimated to reach upwards from 1 billion RMB annually. See: Vennemo, Haakon, Kristin Aunan, Jinghua Fang, Pernille Holtedahl, Tao Hu and Hans Martin Seip, 2005. Domestic environmental benefits of China's energy related CDM potential. Climatic Change, (Accepted). (Kristin Aunan, CICERO Center for International Climate and Environmental Research-Oslo)	
4-1281	A	74	4	74	4	Reduction of air pollution. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Accepted, text changed
4-1282	A	74	4	74	10	RECOMMENDATION: Insert new paragraph at end of Line 10 to read " Nuclear energy shares many of the same co-benefits as renewables. Energy supply security is enhanced due to the decreased reliance on fossil fuel imports and increased diversity of energy supply. Nuclear generation too has relatively high capital costs, compared to fossil generation, but the price of uranium fuel represents only a small percentage of overall generation costs so the overall generation costs are quite stable. (Source: An example of the differences in the contribution made by fuel costs to overall generation costs is given on page 22 of Impact of U.S. Nuclear Generation on Greenhouse Gas Emissions Ronald E. Hagen, John R. Moens, and Zdenek D. Nikodem. Energy Information Administration U.S. Department of Energy. Available at http://tonto.eia.doe.gov/FTPROOT/nuclear/ghg.pdf) (Jonathan Cobb, World Nuclear Association)	Accepted The main points of suggested text could be included and the reference added Acccepted, short sentence and reference added (Clive)
4-1283	A	74	12		16	There is a vast amount of articles etc. since 2000 on the subject of learning/experience curves of new (and 'old') energy technologies. An example is (but there are many, often coupled to models mentioned in Section 4.9.3.): Van der Zwaan, B. and Seebregts, A. (2004) 'Endogenous learning in climate-energy-economic models – an inventory of key uncertainties', Int. J. Energy Technology and Policy, Vol. 2, Nos. 1/2, pp.130–141. (Ad Seebregts, Energy research Centre of the Netherlands)	Noted, new references will be considered (Clive)
4-1284	A	74	19	74	19	RECOMMENDATION: Modify the text to read "Many forms of mitigation technologies offers economic co-benefits of…" JUSTIFICATION: The text is dominated by references to the co-benefits of renewables. In the case of this sentence other mitigation options, including nuclear, could have been used to give a	Accepted In selected places nuclear could be included as an additional option having similar co-benefits. Accepted, text will be modified

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						greater balance to the text. (Jonathan Cobb, World Nuclear Association)	(Clive)
4-1285	A	74	22	74	22	RECOMMENDATION: Add after "...installation and maintenance." the text "Nuclear generation creates a wide range of jobs, in both the construction and operation of the plant. The development of nuclear generation capacity creates highly skilled jobs." Source: CERI, Economic impact of the nuclear industry in Canada 2003. (Jonathan Cobb, World Nuclear Association)	Noted The suggestion will be considered, although the nuclear power is not equally manpower-intensive. Anyhow, for high-skill jobs there could be spin-offs to other technology fields. Accepted, text will be modified (Clive)
4-1286	A	74	23	74	27	We know how difficult it is to assess the employment effects of the development of new technologies. In particular, it is very hard to measure indirect (sectorial or macroeconomic) employment effects. We are surprised that only a single figure is mentioned (instead of a range). Moreover, the reference dates back to 5 years ago (6 years by the time of the publication of AR4), which is a very long time period given that the use of some energy sources (wind energy for instance) has increased exponentially. Even if such studies are rather scarce (see also for instance Cabinet Office UK (2001), The Energy Review, February 2001), we would urge the authors to look at them and to establish an uncertainty range. If not possible, we recommend to present the figures as indicative. (Peter Wittoeck, Belgian Federal Administration)	Accepted, references will be looked at (Clive)
4-1287	A	74	27	74	25	The reference is not in the REFERENCES list. (Peter Wittoeck, Belgian Federal Administration)	Rejected
4-1288	A	75	15			Add reference: Kessels, J.R.; Bakker, S.J.A., 2005, ESCAPE: Energy Security & ClimAte Policy Evaluation, ECN-C--05-032, ECN, Petten, the Netherlands. http://www.ecn.nl/library/reports/2005/c05032.html (Ad Seebregts, Energy research Centre of the Netherlands)	Noted, reference will be looked at (Clive)
4-1289	A	75	17			It is noted that subchapter 4.7.4 is limited in ist assessment to implications of energy supply systems on sustainable development in developing countries. It seems very important to address the same topic also for developed countries. (Radunsky Klaus, Umweltbundesamt)	Accepted, text will be updated (Clive)
4-1290	A	75	21	76	38	This discussion is very one-sided, considering that earlier in the draft the point was stressed that access to energy and energy services was one of the key parameters for achieving sustainable development. On Pg. 75, lines 38-39, the text acknowledges that the technology to control the emissions causing the problem in Kazakhstan exists and is in use in other parts of the world. The same is true for the other problems related to oil production discussed in this section. A more balanced approach would also discuss the responsibilities of the governments involved to use	Noted, text will be reviewed and modified appropriately (Clive)

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						part of the revenues they are deriving from oil production to protect the health of their citizens. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	
4-1291	A	75	22			Section 4.7.4.1 "Health and environment" mentions health effects of traditional biomass but not environmental consequences of unsustainable biomass extraction. Could also stress possitive opportunities of some energy crops in relation to sustainable development: see comment above (Ch. 4, pp40, line 7-9). (Göran Berndes, Chalmers University of Technology)	Rejected, covered by ch 8
4-1292	A	75	0	76		Section 4.7.4.1 only describes impacts on health & environment of oil, coal, wood, or specific electricity generation sets. Nothing is mentioned about nuclear or environmental effects of specific large scale renewable sources (e.g. large hydro projects). In this sense, the section is incomplete and selective. (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted This section needs to be completed. Discussion of safety and environmental impacts of nuclear energy will be adde to section 4.3.2 and that can then be cross-referenced in Section 4.7.4.1. Rejected, more a social problem.
4-1293	A	76	41	77	19	This section correctly states on Pg. 76, line 46, that there are now some genuine efforts to address the injustices caused by misappropriation of resources. These should be described. Policymakers and other readers need to be informed about the efforts to solve the problems described in section. A 1999 reference is used to justify the statement that the greater the dependence of a country on oil, the worse its growth performance. Is that still true? Recent reports indicate that Saudi Arabia, probably the country with the greatest dependence on oil, is making efforts to diversify its economy and to promote other forms of economic growth. Finally, as currently written the section places all of the blame for these inequities on multi-national corporations. However, the host country derives more than half, and in some cases as much as 80% of the oil revenue. Is not a large part of the problem poor governance in the host countries? Oil rich developed countries (e.g. Norway) ensure that their oil revenues are used to benefit the whole of society. It is facile but unfair not to place part of the blame on the corruption and lack of rule of law that exists in many developed countries. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Noted, text will be reviewed and modified appropriately (Clive)
4-1294	A	76	41			Subchapter 4.7.4.2: It is noted that the equity issues raised in this chapter are not linked to climate change issues but that they are a much broader issue that is not limited to the energy sector. From that perspective it seems appropriate to consider to delete this subchapter in its entirety. It clearly would be beyond the scope of the AR4 to address such issues. It seems much more useful to keep the AR4 focused on	Rejected

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						the main issues. Otherwise the IPCC might risk to loose its high reputation. (Radunsky Klaus, Umweltbundesamt)	
4-1295	A	76	43	77	19	This whole section is accusatory in tone and not backed up by any sound literature source. One source (Bonifaz, 2004) is a Canadian TV program. The tone of the entire section is unbalanced, with no thoughts given to the actual roles of governments and, in some cases, the failure of governments. Also, what is the purpose of making an inflammatory statement "... not only are many multinationals financially stronger than poor developing nations..."? Is there any policy relevance to this in the context of climate change? Companies are only given a license to operate by the host government. Further, companies have to submit competitive bids to get that permit. This was never mentioned. Finally, this section completely ignores all the work conducted under the Global Gas Flaring Reduction Partnership, aimed at helping to reduce flaring emissions and thus conserving hydrocarbon resources for the host country. There is a lot of literature available on the GGFR. (Arthur Lee, Chevron Corporation)	Noted, text will be reviewed and modified appropriately (Clive)
4-1296	A	77	22			Subchapter 4.7.4.3: It is noted that most of this subchapters is not linked to climate change issues. Therefore it is proposed to delete this subchapter beginng from line 28 ("The scaling down of staff …) because it might be beyond the scope of the AR4 to address such issues. It seems much more useful to keep the AR4 focused on the main issues. Otherwise the IPCC might risk to loose its high reputation. (Radunsky Klaus, Umweltbundesamt)	Accepted, section deleted
4-1297	A	78	13	78	15	The International Partnership in Global Gas Flaring Reduction (GGFR), an international public-private partnership involving the World Bank, 10 developed and developing nation governments, and 9 international oil companies, has been formed with the goal of eliminating unnecessary gas flaring. Details of this partnership can be found on the World Bank website and searching for GGFR. Unfortunately the web address is very long and cannot be reasonably copied. However, if you call attention to the problem, fairness dictates that you also discuss to the efforts being made to solve it. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted, text we will be added (Clive)
4-1298	A	78	32	78	32	Corruption, going along with bureaucracy, … (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE	Accepted, text changed

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						DEVELOPMENT)	
4-1299	A	79	19	79	21	These sentences introduce a description of the situation in Niger where the use of biomass fuels has not been sustainable, causing a shift to coal. We would suggest changing the sentences to say, "Efficient use of biomass fuels can reduce CO2 emissions if they replace fossil fuels. These benefits can only be sustained, however, if biomass supplies are adequate to satisfy demand without depleting biomass carbon stocks. If supplies are inadequate, it may be necessary to shift demand to fossil fuels to prevent over harvesting." The text currently says, "Use of modern biomass fuels when produced in a sustainable manner is generally considered favourably. However their sustainable production remains a challenge and forces a shift towards other more unsustainable energy systems." The alternative text we have suggested is more precise and helps reinforce the important concepts that (a) efficient use of biomass is important and (b) biomass supplies must be replenished if the benefits of biomass fuels are to be sustained. (Reid Miner, NCASI)	Accepted, text will be changed (Clive)
4-1300	A	79	40			Section 4.7.4.5 instead of 4.7.4.6 (Ad Seebregts, Energy research Centre of the Netherlands)	Rejected
4-1301	A	79	40			Section 4.7.4.6 Strategies for providing energy for sustainable development. The general observation on the chapter as a whole (see above) can be supported by consideration of this vital section---arguably the most important section in the entire report in terms of what will be most expected from it by a readership in search of answers to the mitigation problem. At less than 40 lines long the list of answers cannot be considered comprehensive. Those that are provided are hardly relevant to speedy conversion of the energy supply system from a high carbon to a low carbon basis. (See below) (Pat Finnegan, Grian)	Accepted, this will be addressed in a special section (Joergen)
4-1302	A	79	40	80	20	heading section 4.7.4.6 mentions "strategies", the content of the section is on instruments however (financial, information provision, funds). This is not a question of a change in the title. What is expected in this place in the chapter is the conclusion of the preceding sections in 4.7 in terms of the strategic choices that can benefit both the environment (climate in particular) and other aspects of sustainable development. After the section on barriers the reader expects to read about solutions. The existing text on instruments (shortened, are all examples needed?) could then be placed at the end to demonstrate how the sustainable solutions can be stimulated. (Peter Bosch, IPCC TSU WGIII)	Accepted, this will be addressed in a special section (Joergen)

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4-1303	A	79	0	80		The 4 briefly described examples are not really strategies but merely 'means'. Moreover, is there al there is? (Ad Seebregts, Energy research Centre of the Netherlands)	Accepted, this will be addressed in a special section (Joergen)
4-1304	A	80	20			In some countries, may be, is neccesary to modify the actual legal frame to improve a better access to alternative energy resources with low carbon content. (Ramiro Juan Trujillo Blanco, National Programme on Climate Changes)	Rejected, no connection to text
4-1305	A	80	20			In developing countries establish mechanisms for intersectoral planning to develop the productive sector in isolated areas with the participation of the energy sector, educational sector, financial sector and others (Ramiro Juan Trujillo Blanco, National Programme on Climate Changes)	Rejected, no connection to text
4-1306	A	80	20			Establishment of the wind, small hydro maps and define the energy potential. (Ramiro Juan Trujillo Blanco, National Programme on Climate Changes)	Rejected, no connection to text
4-1307	A	80	23			4.7.4.7 should be 4.7.5 (Ad Seebregts, Energy research Centre of the Netherlands)	Rejected
4-1308	A	80	23			It is noted that subchapter 4.7.4.7 is dedicated to vulnerability and adaptation although report 3 of the AR4 should focus on mitigation. It is proposed to integrate the main findings included in this subchapter in report 2 of the AR4 and to delete this subchapter in report 3. (Radunsky Klaus, Umweltbundesamt)	Rejected, this section covers the impact of CC on energy supply
4-1309	A	80	25	81	12	This section on vulnerability and adaptation could be extended as it is very relevant to developing countries. This section could emphasise the link between climate change and energy options - i.e the extent to which climate restricts the use of some energy options (Mohan Munasinghe, Munasinghe Institute for Development (MIND))	Accepted
4-1310	A	80	33	80	34	In this, a basic first step is to explore the relationship between energy demand and weather conditions. Some recent research attempts focus primarily on electricity demand (ref.: (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Rejected, not relevant for ch.4
4-1311	A	80	35	80	35	Add also heat waves. (ELENA GEORGOPOULOU, NATIONAL OBSERVATORY OF ATHENS / INSTITUTE FOR ENVIRONMENTAL RESEARCH & SUSTAINABLE DEVELOPMENT)	Rejected, not relevant for ch.4
4-1312	A	80	46	80	48	I could not understand this. The other way COP of heat pumps increases with ambient temperature	Rejected, only reference for ch.6

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						(FÉLIX HERNÁNDEZ, IEG-CSIC)	
4-1313	A	81	5	81	6	Future climate changes may also be to the benefit of energy crop yields (and crop yields in general) in some (mainly developed) regions. Also, the amount of land that is suitable for crop production can increase in regions. See, e.g., modelling by the IIASA LUC & Agriculture people. One ref. is Fisher, G. et al (2002) "Climate change and agricultural vulnerability". IIASA report prepared for the World SD Summit in Johannesburg 2002. (Göran Berndes, Chalmers University of Technology)	Accepted, text will be changed (Joergen)
4-1314	A	81	8	81	13	It is proposed to substitute "combat climate change threats" by "mitigate climate change" and to include the message of that paragraph in subchapter 4.8 together with the message that one of the main goals of R&D is to further reduce costs of those mitigation options. (Radunsky Klaus, Umweltbundesamt)	Accepted, text changed
4-1315	A	81	15	84	45	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)	Noted, reference will be looked at (Xilian)
4-1316	A	81	15			In Section 4.8, it is necessary to add the importance of involving diverse stakeholders such as NGOs and local people in energy development projects for attaining sustainable development. (Kenichi Oshima, Ritsumeikan University)	Rejected
4-1317	A	81	16	83	17	Several paragraphs on technology development of a general character can be skipped, referring to ch2. P81, line 16-25 (explanation RD3) P82, line 20-35 (cobenefits of R&D P82 line 43-47 (deployment barriers,see ch2, p.79, l.35) P83, line 13-17 (learning curves) (Peter Bosch, IPCC TSU WGIII)	Noted, will be checked for relevance to energy supply (Xilian)
4-1318	A	81	20			ref not in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Noted,reference is missing (Joergen)
4-1319	A	81	29	81	20	The reference "Sagar (2005) is missing in the literature list (Joachim Schleich, Fraunhofer Institute Systems and Innovation Research)	Noted,reference is missing (Joergen)
4-1320	A	81	40	81	44	This list is not comprehensive and it would be too long to make it comprehensive (for every source of energy there would be a similarly long list¡¡). I suggest you delete it.	Accepted, lines deleted

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						(Juan Carlos Abanades-García, Instituto Nacional del Carbon-CSIC)	
4-1321	A	81	0	84		section 4.8 could more explicitly build upon the technology discussion in chapter 2 and discuss its application to energy systems. Also should acknlowledge that R&D expendiutre is not always a good measure of national technology effort because innovation can be dominated by the private sector. In addition to various IEA sources, also consider the different measures of effort in the UK (eg. Wordsworth, A. and M. Grubb (2003). "Quantifying the UK’s incentives for low carbon investment." Climate Policy 3(1): 77-88.) and the growing investments of the CArbon Trust which also has involved significant co-investment and the support of two fuel cell companies now floated on the London stock exchange (Carbon Trust, Annual Report, 2005, www.carbontrust.co.uk) (Michael Grubb, Cambridge University)	Rejected, irrelevant
4-1322	A	82	12	82	14	Priorities for technology development are in my view highly scenario specific, even with the common goal of greenhouse gas emissions in mind. In A1 or B1 worlds investments in nuclear fusion may be an option, while A2 or B2 worlds will focus much more on decentralised options. Possibly including nuclear power (fission). The line in the report suggests that a common vision could be developed quite easily, but I believe this denies differences in world view. (Albert Faber, Netherlands Environmental Assessment Agency)	Rejected
4-1323	A	82	16			I wouldn't want to say that R&D investments aim at reducing deployment costs. R&D focuses on research and development, but not on the application phase. Here marketing strategies etc. come in (Albert Faber, Netherlands Environmental Assessment Agency)	Rejected, RD3 in the text
4-1324	A	82	19	82	20	4.8.1 Diffusion and Transfer should mention the Asia-Pacific Partnership on Clean Development and Climate which provides a comprehensive programme for diffusion and transfer of technologies. (Koji Kadono, Global Industrial and Social Progress Research Institute)	Accepted, the partnership will be mentioned (Xilian)
4-1325	A	82	24	82	25	Why would procurement processes be inherently conservative? Procurement will depend on the progressiveness of government, but also on the state of democracy, allowing in a sense more 'over the top' procurements by more autocratic regimes. This statement denies such differences (Albert Faber, Netherlands Environmental Assessment Agency)	Accepted, sentence deleted.
4-1326	A	82	25	82	27	The statement that people need to be assured of social benefits by new technologies is way beyond science and deep in the realm of politics. It disregards different views on the advantages as well as on the disadvantages of technologies. See e.g. discussions on nanotechnologies, genetic engineering, magnetic fields around	Accepted, text will be modified (Xilian)

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						powerlines and nuclear power: the social benefits of all of these can easily be argumented, but one should never deny the (sometimes intuitive) dangers, risk and uncertainties this way. (Albert Faber, Netherlands Environmental Assessment Agency)	
4-1327	A	82	29	82	39	See also comment # 4. This is sheer techno-hooray, with focus on selling the advantages of a new technology, without a word on decreasing the (possibly negative) side effects. (Albert Faber, Netherlands Environmental Assessment Agency)	Rejected
4-1328	A	82	41			Perhaps I'm missing the point here but this section seems rather limited given that you have, in passing, referred to the diffusion of the technologies at the bottom of pg 68 (I recognize that it is in a different context) and I would have expected some elaboration here. One of the issues is the distribution of technologies world wide subsequent to R&D being completed and that there are a lot of problems from intellectual property rights to international road blocks and corporate resistance, etc. that prevents distribution. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Rejected, to general
4-1329	A	82	41			Figure 4.8.1 - Should use more current data (at least 2004) (Stan Bull, National Renewable Energy Laboratory)	Noted, will be updated if new data exist(Joergen)
4-1330	A	82	46			Sagar 2005 is not listed among the references (Rainer Walz, Fraunhofer Institute Systems and Innovation Research)	Accepted (Joergen)
4-1331	A	83	3	83	4	It is stated that 'barriers to market uptake need to be overcome so that market growth occurs', but I believe these are two different things, or two different points on the S-curve of technology adoption, so to say: market uptake takes place by early adopters, while market growth is generally associated with adoption by early majority. (See Rogers (1962). Diffusion of innovations. Free Press, NY). (Albert Faber, Netherlands Environmental Assessment Agency)	Rejected
4-1332	A	83	10	83	11	Why is the reduction of technology redundancy a benefit? Technological development often needs squander and waste, as innovation processes needs trial and error. This links with the evolutionary concept of diversity, which allows for variety and heterogeneity of technologies, in order to increase a (economic) system's fitness. See for an excellent overview on diversity: Stirling (2004). Diverse designs, fostering technological diversity in innovation for sustainability. Paper presented at conference 'Innovation, Sustainability and Policy', Seeon (Germany), 23-25 May 2004. See for an exploration of evolutionary concepts in environmental policy: Van den Bergh, Faber, Idenburg and Oosterhuis (2006 forthcoming).	Accepted. Sentence and reference deleted.

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						Survival of the greenest, evolutionary economics and policies for energy innovation. Forthcoming in Evolutionary Science 3 (1). (Albert Faber, Netherlands Environmental Assessment Agency)	
4-1333	A	83	21	83	22	It would be more correct to say that the private sector can benefit from an agreed public framework to operate within. The private sector has traditionally operated without an agreed public framework and has been able to transfer and diffuse many technologies. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted, text changed.
4-1334	A	83	21			ref not in Ref list (Ad Seebregts, Energy research Centre of the Netherlands)	Noted, look for reference (Joergen)
4-1335	A	83	30			Section 4.8.2 comment -- Recent documents of the US Climate Change Technology Program can be cited (see website above); these include measurements of US funding of climate-change-related technology. (Stan Bull, National Renewable Energy Laboratory)	Rejected, website not cited.
4-1336	A	83	30	84		Much emphasis in this part on financial support mechanisms, technology push and R&D. This dilutes the idea that technological development can also be stimulated and steered by (additional) focus on (non-financial) demand pull as well as an innovation system (IS) perspective. With respect to the first, one may want to include incentives through standardisation or target setting. See e.g. the work of M. Porter for further background (Porter & vd Linde (1995). Green and competitive. In: Harvard Business Review 73, pp 120-34; Porter (1991). The competitve advantage of nations). With respect to the innovation system perspective, one can distinguish a variety of functions in an IS, of which financing is only one. Check the work of Lundvall, Hekkert, Nelson, Edquist. We have in preparation an overview of functions for government with respect to environmental innovations, but this will not be published before late in 2006: Kemp, Faber, vd Veen - Innovation policy for the environment. In: Innovation policies in Europe (eds Nauwelaers and Wintjes). (Albert Faber, Netherlands Environmental Assessment Agency)	Rejected, paper not yet available.
4-1337	A	83	32	84	41	This section could reflect themes that are picked up in other chapters in particular the role of international financial institutions, export credit agencies and so on, which do and can play an important role in attracting private sector investment, outside of R&D, see also Chapter 13. (Kirsty Hamilton, retainer to UK Business Council for Sustainable Energy; Associate Fellow, Chatham House.)	Noted, crosscutting issue.
4-1338	A	83	35	83	35	It may be true that before the large increase in energy R&D in the late 1970s	Taken into account

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						investments in nuclear technology greatly exceeded those in renewable energy, but this is no longer the case. Data are not presented to support the statement made here that "Expenditures on nuclear technologies was many times higher than on renewable energies" at the peak of expenditures around 1980. Indeed it seems unlikely that investment in nuclear technology was "many times higher" than $2B/year world-wide in 1980. Investment in fission R&D was about 50% greater than investment in renewables in the U.S. in 1980, and is now much smaller. Government incentives for energy deployment need to be included to provide a complete picture here, since they are comparable to all government investment in energy R&D in the U.S. and in Europe. Similarly, the level of private investment in the various technologies should be assessed as well. Finally, there is a very important benefit/cost analysis issue that is missed here. Because of the large scale required, and the time period longer than intellectual property rights, some technologies, as for example fusion energy, can only be developed by governments. If they are not developed by governments private entities will not do so. Thus while government investments in renewable technologies arguably accelerate their entry into the market place, the societal benefit is only for the years of acceleration, while for fusion technology, for example, the societal benefit is for all the years of potential use of fusion energy. (Robert Goldston, Princeton Plasma Physics Laboratory)	The information suggested needs to be taken into account. Inclusion of temporal behaviour of R&D funding as well as energy form subdivision would clarify the information. Noted this issue will be investigated Joergen)
4-1339	A	83	41	83	45	The author may want to include reference to Garud and Karnøe (2003) Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship. Research Policy 32: 277-300. This paper shows that wind energy support in Denmark focused much on incremental development through learning-by-doing, while the US had an ambitious focus on breakthroughs; overall, the latter never made the level of progress as the Danes did. (Albert Faber, Netherlands Environmental Assessment Agency)	Noted, reference will be looked at (Joergen)
4-1340	A	84	1	84	4	Delete this sentence. The concerns about the decline in energy R&D are legitimate, but the simple comparison between industries on rate of R&D expenditure is not. In absolute terms energy R&D is still a large amount. Energy is a commodity product which does not offer the same R&D challenges as more differentiated products. Also, much of the energy industry's research is conducted by consortia such as the Electric Power Research Institute in the U.S. and GCEP, with results shared among the members of the consortium if not more broadly. (Lenny Bernstein, L. S. Bernstein & Associates, L.L.C.)	Accepted, sentence deleted
4-1341	A	84	3			The comparison of R&D-investments in different sectors does not make much	Accepted, sentence deleted

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						sense to sustain an argument. First, R&D-investments are for a large part dependent on structural factors. E.g. bulk chemicals will increase profits by innovation in production, by decreasing the ratio output/inputs, while fine chemical industries (such as pharmaceuticals) will increase profits by innovation on the final product. The latter takes far more investments on the R&D-level. R&D is thus not in all sectors equally important. Second, R&D is only one parameter to measure innovativeness; others may be more focused on output factors such as patenting. Thirdly, R&D is not in all sectors equally important. E.g. in trade or services, innovations often come by new marketing concepts, improvements in distribution systems, etc. These are usually not thought of in an R&D-department, but e.g. in the sales department, thus being unnoticed in R&D figures. Concluding: as it stands now, the array of sectors in the text is rather arbitrary and it does not make an argument. (Albert Faber, Netherlands Environmental Assessment Agency)	
4-1342	A	84	6			By what criterion is 'insufficient' insufficient? (Albert Faber, Netherlands Environmental Assessment Agency)	Rejected
4-1343	A	84	11	84	14	This sentence is hardly understandable, but I read it that producers will invest their surplus profits in new innovative activities. I cannot see why that would be the case. Why would a producer not invest in increasing the market for the novel concept? (Albert Faber, Netherlands Environmental Assessment Agency)	Accepted, sentence deleted
4-1344	A	84	23	84	25	This text is rather obscure and 'woolly'; what is the point? An argument on why government intervention is justified would make sense here. Economically, this justification is usually made by market failure and system failure. The first shows that underinvestments in R&D can be related to externalities, barriers for market entrance or e.g. monopolies. The second shows that underinvestments in R&D can be related to a poor technology infrastructure, problems of transition, lock in, or institutional barriers. From the perspective of climate change, a governmental policy for innovation is justified by the long-term nature of the problem, which asks for long-term (sideby short-term) solutions and thus a focus on accelerating learning curves of certain technologies. On this last issue a good reference is by one of your co-authors: Nakicenovic (2002). Technological change and diffusion as a learning process, pp. 160-181 in Grübler, Nakicenovic and Nordhaus (eds) - Technological change and the environment (Albert Faber, Netherlands Environmental Assessment Agency)	Noted, the reference will be looked at (Joergen)
4-1345	A	84	35	84	37	This is direct policy advice. My advice would be to refrain from that in a	Accepted, sentence deleted.

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						supposedly neutral IPCC report. (Albert Faber, Netherlands Environmental Assessment Agency)	
4-1346	A	84	35	84	41	It is necessary to refer to the mportance of involving stakefolders such as NPO in energy development projects for attaining sustainable development. (Masatake Uezono, Citizens' Alliance for saving the Atmosphere and the Earth)	Rejected.
4-1347	A	84	44			Section 4.9.1 - A gap appears between the (updated) analysis of energy sources mentioned in this draft report and the (outdated) global energy scenarios, mostly based on studies that were done in the 90s by IIASA-WEC and IPCC (SRES). IEA 2004 Alternative scenario and IEA 2005 Sustainable scenario for 2050 are simply mentioned. Among hypothesis and assumptions that appear outdated, let us mention: World population prospects for 2050: the medium variant of UN 2004 revision is 9.1. billion inhabitants (thus lower than 10.1 as in IIASA/WEC 1998); Too high level of energy demand in 2050 in "reference" scenarios; Malthusian association of reduced energy demand with reduced economic growth; real policies of end-use energy higher efficiency and demand savings as in IEA 2004 alternative scenario are not taken into account; Relative "unilateral" choices in favour of one dominant energy source (that is different among the scenarios), including gas. The last remark intends to emphasize that a sustainable solution to curb CO2 emissions significantly necessarily requires a widely diversified energy mix of all the best available technologies over the next 3 decades (both on demand and supply side). As is well emphasized by the draft report, R&D is urgent to prepare future CO2 free technologies. But this appropriate element of a long term climate strategy seems inappropriate to curb CO2 emissions over the next 3-4 decades. On the other hand, a well diversified energy mix of available technologies (coal, gas, hydro, nuclear, renewable) allows for significant worldwide CO2 emission reduction at "reasonable" cost (let us say at less than 100 $/tC by 2030-2040).	Noted. Section deleted

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						The previous comments stress that it would be important to discuss these issues , may be in another part of the report (for instance chapter 3). In the case where no new scenarios, taking into account these new knowledge and facts on technologies, would be available to be discussed by AR4, it should be pointed out that there will be a need to take stock of this new matter in a near future. (Jean-Yves CANEILL, Electricité de France)	
4-1348	A	84	46			Section 4.9.3. Previous comments on ZOD are not taken into account. I repeat them here. Moreover, I provide some additional references. There may be more than just energy models as 'Decision tools'. There may be more than these types of models. The recent liberalisation of energy markets, has led to a variety of energy market models, which are quite different than the 'old' bottom-up up energy systems models. In addition, a variety of other integrated models exits, either global (e.g. the POLES model, ERIS, TIMES). E.g. Reference TIMES: Remme, U.; Goldstein, G.; Schellmann, U.; Schlenzig, C. (2002): MESAP/Times - Advanced Decision Support for Energy and Environmental Planning, In: Chamoni, P et al (Eds.) (2002): Operations Research Proceedings 2001: Selected Papers of the International Conference on Operations Research (OR 2001), Duisburg, September 3-5, 2001, ISBN:3540433449, Springer Verlag, October 2002, pp. 59-66. (Ad Seebregts, Energy research Centre of the Netherlands)	Section deleted
4-1349	A	84	46			Better title: 4.9.1 Future scenarios to support decision making (Ad Seebregts, Energy research Centre of the Netherlands)	Section deleted
4-1350	A	84	46	85	45	It is necessary to add the description about the meaning of scenarios for Decision Making Process. (Kenichi Oshima, Ritsumeikan University)	Section deleted
4-1351	A	84	48	84	50	The comment (4,79,40 on section 4.7.4.6)can be situated against this chapter's own view of the long term outlook: "The effectiveness of the decision making process regarding long term energy options will depend on the availability of robust future scenarios and a knowledge of the risks associated with each one". Unfortunately, the contents of this chapter (at leat in its current shape) do not inspire confidence that effectiveness of mitigation will be enhanced on foot of its consideration. (Pat Finnegan, Grian)	Section deleted
4-1352	A	85	7	85	7	It is not reasonable in the context of a discussion of global climate to consider a	Noted

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						projection to 2050 "long term." It would be more appropriate to use projections at least to the end of this century, as e.g., shown in the US Climate Change Technology Program, Strategic Plan, Proposed Draft for Public Comment - September 2005. There they provided three scenarios out to 2100 with emphasis, respectively, on 1) Fosssil + Carbon Capture, 2) Renewables and Nuclear, 3) Advanced Energy Systems. It would be very desirable to include, or at least call for, projections to the end of the next century, where the challenge is much, much greater. (Robert Goldston, Princeton Plasma Physics Laboratory)	Terminology could be checked Timeframes beyond 2050 could be "very long-term". Section deleted
4-1353	A	85	0	87		I am not sure how helpful the brief section in 3.9 on models is. In my view, this section should be about application of decision processes to investment in the energy sector - the real key is reorienting the scale of private sector investment to minimise exposure in carbon-intensive assets, drawing on the IEA work. (Michael Grubb, Cambridge University)	Section deleted
4-1354	A	86	1			Inertia is also a function of the consumer; their view of nuclear power, "green" energy, utility management and perhaps the energy service industry in general may be one of the causes preventing more widespread use of available technologies. (John Nyboer, Energy and Materials Reseach Group, School of Resource and Environmental Management, Simon Fraser Univeristy)	Noted The issue of needed broader social acceptance is mentioned in section 4.3.2 on nuclear energy. Section deleted
4-1355	A	86	1			Better title: 4.9.2 Barriers (Barriers from different kinds causing the energy system to be relatively inert) (Ad Seebregts, Energy research Centre of the Netherlands)	Section deleted
4-1356	A	86	5	86	6	Need to specify who developed the AIM model. (Koji Kadono, Global Industrial and Social Progress Research Institute)	Section deleted
4-1357	A	86	22	87	42	Subsection 4.9.3: As energy models, MERGE (Manne, A.,and R. Richels, 2004: The impact of learning-by-doing on the timing and costs of CO2 abatement. Energy Economics 26(4), pp.603-619.) and GRAPE (Kurosawa, A., 2004: Carbon concentration target and technological choice. Energy Economics 26(4), pp.675-684.) are recommended to be included here. (Takanobu Kosugi, Ritsumeikan University)	Section deleted
4-1358	A	86	22			Better title: 4.9.3 Energy planning or scenario models (Ad Seebregts, Energy research Centre of the Netherlands)	Section deleted
4-1359	A	86	23			You might want to introduce IEA's World Energy Model here. You can find the description of the model at http://www.worldenergyoutlook.org/docs/World_Energy_model_2005.pdf. (Fatih Birol, International Energy Agency)	Section deleted

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4-1360	A	86	24	87	42	Models, including the energy models discussed in this section, so far as I can recall have been discussed elsewhere in this FOD. (Michael Jefferson, World Renewable Energy Network/Congresses)	Section deleted
4-1361	A	86	34			It is evident that within the framework of this report a complete ovverview and model description is impossible. So it is ok to say these models include….and give a number of examples. However, here the examples seem to be not very representative: 3 models from Japan, no model from the USA, ..? What is more: thes selected few are even described in some detail: why? either you give some examples and stop there are you have a comprehensive overview not picking somme using unknown criteria .what about NEMS , SAGE, MERGE, PACE, GEM-E3, PRIMES, POLES, TIMER, TIMES,…… (Peter Russ, IPTS, Joint Research Centre, European Commission)	Section deleted
4-1362	A	86	35		43	Additional, new references on the MARKAL family of models: e.g. those after Climate Change 2001: Mitigation (Table 8.1 p 505). Sp, basically references 2000 and later e.g. Seebregts, Ad J, Gary A Goldstein, Koen Smekens (2002): Energy/Environmental Modeling with the MARKAL Family of Models, In: Chamoni, P et al. (Ed.) (2002): Operations Research Proceedings 2001: Selected Papers of the International Conference on Operations Research (OR 2001), Duisburg, September 3-5, 2001, ISBN:3540433449, Springer Verlag, October 2002, pp. 75-82. Morris, S., Goldstein, G., and Fthenakis, V. (2002). NEMS and MARKAL-MACRO Models for Energy-Environmental-Economic Analysis: A Comparison of the Electricity and Carbon Reductions Projections. Environmental Modeling and Assessment 7, 207-216. Seebregts, AJ, Kram, T, Schaeffer, GJ, Bos AJM (2000): Endogenous learning of technology clusters in a MARKAL model of the Western European energy system. Int. J. Global Energy Issues, 14: 289-319. Barreto, L. and S. Kypreos (2002), "Multi-regional Technological Learning in the Energy Systems MARKAL Model", International Journal of Global Energy Issues, 17, 189-213. (Ad Seebregts, Energy research Centre of the Netherlands)	Section deleted
4-1363	A	86	35		43	Add: "The MARKAL family of models (and TIMES) has (have) been developed under auspices of IEA's Energy Technology Systems Analysis Programme (ETSAP, see www.etsap.org) as a joint undertaking of that research community. (Ad Seebregts, Energy research Centre of the Netherlands)	Section deleted

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
4-1364	A	87	3	87	3	Please spell my family name correctly. (Leo Schrattenholzer, IIASA)	Section deleted
4-1365	A	87	21	87	21	Replace "carbon sequestration technologies" by "biological carbon sequestration and CCS technologies". (CZERNICHOWSKI-LAURIOL Isabelle, BRGM)	Section moved. Agree
4-1366	A	87	26	87	32	I suspect DEN 21 model is meant to be DNE21+ model. (Koji Kadono, Global Industrial and Social Progress Research Institute)	Section deleted
4-1367	A	87	46			References for comments on Chapter 4: S. Caserini, L. Marazzi, G. M. Crovetto, A. B. Denti, M. Lapi, G.Fossati, A.Fraccaroli, L.Gurrieri (2005a) "Extensive survey on wood use for domestic heating in Lombardy: implication for PM emission inventory," 14th International Emission Inventory Conference "Transforming Emission Inventories - Meeting Future Challenges Today", US Environmental Protection Agency, Clearwater, Las Vegas, 11-14 aprile 2005, http://www.epa.gov/ttn/chief/conference/ei14/ S.Caserini, A.M.Monguzzi, A.Fraccaroli, M.Moretti, E.Angelino, G.Fossati, A.Giudici (2005b) L'inventario delle emissioni in atmosfera in Lombardia: stato dell'arte e prospettive. (in italian) Ingegneria Ambientale, XXXIV/5, 222-233 AEAT (2004) Costs and environmental effectiveness of options for reducing air pollution from small-scale combustion installations. Final Report for European Commission DG Environment AEAT/ED48256/Final Report Issue 2 (Stefano Caserini, Politecnico di Milano)	Thanks. Will note
4-1368	A	87	0			REFERENCES. A few general remarks. Text references to websites (often like (www.website.org) should be also in References section, with data when downloaded etc. Web pages may be removed in the future and information may consequently not be retrievable anymore. Although fairly complete (compared to ZOD) some references are not yet in list. These are indicated as comments on the relevant pages/lines in the main text. (Ad Seebregts, Energy research Centre of the Netherlands)	Agree
4-1369	A	96	24	96	24	and FORESTRY (Kenneth Möllersten, Swedish Energy Agency)	Agree
4-3	B	0	0	0	0	Possibly useful reports: Larsen, Hans and Leif Soenderberg Petersen, 2002. New and emerging technologies - options for the future. Risoe Energy report 1, Risoe Denmark. Larsen, Hans and Leif Soenderberg Petersen, 2005. The future energy system - Distributed Production and Use. Risoe Energy report 4, Risoe, Denmark. Larsen, Hans, Robert Feidenhans and Leif Soenderberg Petersen, 2004. Hydrogen and its competitors. Risoe Energy report 3, Risoe	Thanks

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						Denmark. Larsen, Hans, Jess Kssman and Leif Soenderberg Petersen, 2003. New and emerging bioenergy options. Risoe Energy report 2, Risoe, Denmark. (see: http://www.risoe.dk/rispubl/energy_report/ris-r-1430.htm and search for the others) (Peter Bosch, IPCC TSU WGIII)	
4-4	B	0	0	0	0	Not peer reviewed, but in the category useful global overviews, with e.g. overviews of renewable energy promotion policies per country, existing renewable capacities, etc. is the following report: REN21 Renewable Energy Policy Network, 2005. Renewables 2005 Global Status Report. Washington DC: Worldwatch Institute. (see: http://www.martinot.info/re2005.htm) (Peter Bosch, IPCC TSU WGIII)	Already in FOD thanks
4-5	B	3	19	3	25	This is mush; the report should say something worth thinking about. (Michael Golay, MIT)	Will discuss
4-6	B	3	37	3	38	The statement "It is well understood that the global dependence on fossil fuels has led to the release of over 350 GtC into the atmosphere since 1850." lacks to mention that cumulative emissions by developing countries since 1850 have been very little compared to those of industrialized countries, and it is the build-up of greenhouse gases in the atmosphere that causes climate change. Cumulative emissions by developing countries would not catch up those of industrialized countries for approximately a hundred years (1) This important fact needs to be added. (1) Johansson, T.B. and Karlsson, G.V. Mitigating Climate Change Impacts through Sustainable Development. In Climate Change and Development. pp.88 UNDP and Yale School of Forestry and Environmental Studies (2000) (Adnan Shihab-Eldin, OPEC)	Agreed
4-7	B	3	8	3	10	Statement is needlessly incorrect in that no theory applied to govern how energy was used; societies simply used what was available. (Michael Golay, MIT)	Accept
4-8	B	3	40	0	0	Acceptable to whom. Statements reflecting value judgments are worse than useless in a report like this and must be extinguished. The FOD report has a weakness for this sort of writing. A word search and destroy mission for adjective like this would be a good start to improving this report. (Michael Golay, MIT)	Accepted
4-9	B	4	22	4	27	Unclear what is meant here. What low emitting technologies are those? Clean fossil fuel technologies? Carbon capture and storage? Just renewable systems? Most countries will not choose unfamiliar or more expensive technology options solely	Reworded

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						because they would help mitigate climate change impact. Concerns about current local air quality and adverse health conditions are likely to be more compelling, but low-emission technologies options also have to provide affordable, reliable, effective and convenient energy supplies, and this is not always the case. This paragraph needs to be written again and be more precise. (Adnan Shihab-Eldin, OPEC)	
4-10	B	4	42	4	44	Suggest adding "The choice of policies and measures is not an easy task. It depends on many factors including costs, potential capacity, the extent to which emissions must be reduced, environmental and economic impacts, rates at which the technology can be introduced, and social factors such as public acceptance. Also, in the implementation of policies and measures governments need to give full consideration to actions to meet the specific needs and concerns of developing countries arising from the adverse effects of climate change and/or the impact of the measures on countries whose economies are highly dependent on income generated from the production, processing and export, and/or consumption of fossil fuels" (2,3) (2) United Nations Framework Convention on Climate Change. Article 4.8 (3) Kyoto Protocol. Article 3.2 It would also seem necessary to state here that P&M have to take account of different national circumstances. (Adnan Shihab-Eldin, OPEC)	Accepted
4-11	B	4	42	4	46	It is true and important that governments need to intervene in energy markets is climate change is to be arrested, to the point that the reasoning behind the statement should be explained, as any market intervention to reduce fossil fuel consumption must rest upon then ideas implied here. The basic reason is that market competition alone is highly unlikely to lead to the substitution of fossil fuel consumption that is needed in order to arrest the increase of global temperatures. (Michael Golay, MIT)	accepted
4-12	B	4	21	4	37	Complaints about energy subsidies should not be directed only at fossil fuels. Most fuels and countries offer subsidies. If the author wishes to complain about this reality, then ok; but let him be clear that they apply much more broadly than to fossil fuels and are usually economically inefficient over the entire energy technology portfolio and incoherent. (Michael Golay, MIT)	Accept
4-13	B	4	39	0	0	Optimum is not an adjective. (Michael Golay, MIT)	Changed
4-14	B	6	17	6	20	Obvious and unnecessary to say.	Delete

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Michael Golay, MIT)	
4-15	B	7	6	0	0	"value proposition"!!! (Michael Golay, MIT)	Reject
4-16	B	7	31	0	0	: Unacceptable to whom? Most people on earth live with "unacceptable" conditions which they have no choice but to accept. The editors should get new authors who can write logically; this section is a mess and needs to be rewritten. (Michael Golay, MIT)	Reworded
4-17	B	8	8	8	10	Eschew useless and unjustifiable speculation such as we have here (Michael Golay, MIT)	Reject
4-18	B	8	31	8	44	"Will"!!! (Michael Golay, MIT)	Accept
4-19	B	8	8	0	0	60% is a closer value than that stated in the text (Michael Golay, MIT)	Reference needed
4-20	B	9	0	0	0	Summarize as a Table. (Michael Golay, MIT)	Deleted
4-21	B	11	40	11	44	No evidence exists for the statement made that energy market liberalization has led to relative decline in environmental protection, which even if true somewhere is likely not true in most places. How the environment is treated usually depends upon regulatory laws, which can be enforced independently of the market mechanisms in place – provided that the rule of law applies in the nation of interest. The report is not helped by such overreaching and ideologically motivated speculations. (Michael Golay, MIT)	Deleted
4-22	B	11	45	0	0	That a resource is finite and non-renewable does not imply that it should not be exploited under a sustainable use rubric (as the text implies). The real question re sustainability concerns whether exploitation of a resource can result in an increase in a society's economic surplus to the extent that we and future generations are better off for coping with the future than had the resourced been left in the ground. It is not really about the simple-minded idea that if we use something enough eventually we won't have any of it left. If we were to follow the implicit logic of a requirement for not using finite resources we would still be living in caves and dying at the age of 20. These ideas are crucial to the thrust of this report and should be presented clearly; not in the form of the sentimental mush expressed here. (Michael Golay, MIT)	Accept
4-23	B	13	31	13	49	Ditto, also awful English. This report has far too many authors whose writings are neither logical nor well expressed.	Accept

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Michael Golay, MIT)	
4-24	B	16	48	0	0	Read what it says; is that really what you mean? (Michael Golay, MIT)	Deleted
4-25	B	17	11	17	15	Why is no mention made of nuclear power use in Korea and China, both of which have much more rapid growth and likely more significant roles for it in alleviating global warming than in Japan, where economic growth can most likely be expected to be much slower. (Michael Golay, MIT)	Accept
4-26	B	18	3	18	5	"Will"!!! (Michael Golay, MIT)	Accept
4-27	B	19	44	0	0	Replace "or" by "and". (Michael Golay, MIT)	Accept
4-28	B	20	49	0	0	A para. is needed here saying that all of these fossil fuel options will plausibly come into use if we leave matters to the marketplace alone to decide upon the technological winners. Economically fossil fuels have large advantages, which the other technologies may not be able to overcome (surely the record to-date does not encourage confidence about this). The idea that the path to preventing global warming lies in making the alternatives economically superior (the main route emphasized so far), in the absence of greater internalization of the fossil fuel externalities, may turn out to be a colossal error, one that could ruin much of the planet. While we must improve the non-fossil technologies where feasible it is likely more important that we render the fossil ones uneconomic via intervention in the marketplace (i.e., via taxes, permits, prohibitions and improved fossil technologies). The justification is avoidance of the environmental and health costs of using the fossil fuels. These currently are imposed upon the world as externalities. (Michael Golay, MIT)	Agree
4-29	B	24	24	0	0	The difficulties in many countries of siting LNG transfer facilities should be discussed here. They constitute a large barrier to expanded use of LNG. (Michael Golay, MIT)	Accept
4-30	B	27	4	0	0	hard to determine => somewhat uncertain. (Michael Golay, MIT)	Accept
4-31	B	27	47	0	0	CCS = ? (Michael Golay, MIT)	Write in full
4-32	B	27	42	0	0	A section is needed here regarding the likely environmental disruptions implied by use of unconventional oil shale and tar sands, with large scale mining and water and	In hand. Accept

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						natural gas use far in excess of what we encounter with conventional petroleum production. Whether societies will be willing to accept them remains unclear. (Michael Golay, MIT)	
4-33	B	29	30	29	49	Spell out the hazards being discussed, anyone who knows what they area does not also need to read what is written here. (Michael Golay, MIT)	Will refer to SRIPCC This section being reduced. Action Bill
4-34	B	30	31	30	36	Unhelpful speculation! (Michael Golay, MIT)	Ref was SRIPCC. Reject
4-35	B	31	4	0	0	demonstrated => demonstrated as an engineering approach. (Michael Golay, MIT)	Accept. Bill
4-36	B	31	21	0	0	Commercially => the commercial viability of projects. (Michael Golay, MIT)	Accept
4-37	B	32	25	32	29	What is meant here is unclear, and the text should be rewritten. It appears that what the author means is that in order for nuclear power to be rendered acceptable in different societies it will likely be necessary for them to come to a different appreciation of the attributes of nuclear power (good and bad) vs. those of the alternatives, particularly should the latter become viewed as less attractive than they have been during recent decades. (Michael Golay, MIT)	Accepted Text will be revised to improve clarity. In addition to public – and more specifically the decision-makers need to put different attributes and different alternatives in perspective with each other.
4-38	B	32	24	32	25	It is not clear that nuclear power will be required to become more appreciated in the future than to-date; could acceptability not be achieved simply via the non-nuclear alternatives becoming less appreciated? (Michael Golay, MIT)	Accepted The text will be revised to this end.
4-39	B	32	43	32	44	In addition to WNA, quote for Europe "Commission of the European Communities, ERM Energy, Dilemma study: Study of the Contribution of Nuclear Power to the Reduction of Carbon Dioxide Emissions from Electricity Generation, July 1999", for the world "Hans-Holger Rogner Nuclear Power and Climate Change, World Climate Change Conference (WCCC), Moscow (29 September - 3 October 2003)" and "OECD/NEA, Nuclear Energy and the Kyoto Protocol, 2002" (Nicole DELLERO, AREVA- Erratum)	Accepted These references will be accounted for and cited.
4-40	B	32	38	32	41	Discussion of low concentration U-resources should note that their exploitation would likely be accompanied by major environmental disruptions of landscapes, habitat and individual creature fatalities. It is not clear that societies would be willing to tolerate such. They might prefer much more fuel-efficient reactors for example. (Michael Golay, MIT)	Taken into account Discussion of these aspects will be added.

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4-41	B	32	0	35	0	The nuclear power section is too small, given the importance of this technology for climate change mitigation. The space allowed permits only a shallow discussion of many important matters, and results in silence concerning others (e.g., safety, economics, factors likely to affect public acceptance, nuclear weapons proliferation). Both nuclear power, wind and hydro are available as the main available practical options that can make a serious difference concerning climate change today. This reality should be recognized in this report relative to the discussions of the other technologies, where its value is diminished by failing to do so. (Michael Golay, MIT)	Accepted Some additional text will be include if possible taking into account the general need to shorten Ch4.
4-42	B	32	37	0	0	significant => large. (Michael Golay, MIT)	Accepted
4-43	B	32	48	0	0	significant => large. (Michael Golay, MIT)	Accepted
4-44	B	32	41	0	0	Ref. Is needed. (Michael Golay, MIT)	Taken into account References from WEC2004b plus some others will be added.
4-45	B	33	19	0	0	The time scales of potential use supportable from known fuel reserves estimated in the report are misleading, as the values presented are based upon current rates of consumption, which are almost surely to be much lower than those that would obtain under any scenario where nuclear power would play a serious role in mitigating global warming. (Michael Golay, MIT)	Taken into account As the scenarios for nuclear power in most cases predict only modest growth, the present consumption level gives a good approximate illustration of the magnitude of reserves. In case of faster growth advanced reactors/fuel cycle will gradually improve the efficiency of resource utilization in time scales beyond 2030.
4-46	B	33	15	0	0	The distinctions between Th- and U-based reactors should be explained here, as they are large and not widely understood among the audience for this report; also the proliferation implications and resource base differences should be discussed. (Michael Golay, MIT)	Taken into account Short explanation will be added; stating the lower maturity of Th-based fuel cycle.
4-47	B	33	11	0	0	Presumably <1% refers to the 235-U content of the spent fuel. If so the text should say this; if not it should explain what is meant. (Michael Golay, MIT)	Taken into account Primary intention is to refer to the natural contents of U-235.
4-48	B	33	14	0	0	present => current. (Michael Golay, MIT)	Accepted
4-49	B	33	5	0	0	P&T=?	Accepted

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						(Michael Golay, MIT)	
4-50	B	33	26	0	0	earmarked= ? (Michael Golay, MIT)	Taken into account Means committed for lifetime uranium requirement for the reactor fleet at that capacity level.
4-51	B	33	30	0	0	An energy economy where fossil fuels are displaced by nuclear and the renewables is likely to be characterized by much more expensive energy, with the result that many things that are uneconomical today may not be so tomorrow. The text should recognize this. (Michael Golay, MIT)	Accepted This aspect will be mentioned. As said, applies also renewables. Therefore this aspect could (also) be brought up in section dealing with costs and potentials of mitigation options.
4-52	B	34	17	34	19	What the text is trying to say is unclear: (Michael Golay, MIT)	Taken into account Based on other comments sentence will be revised completely.
4-53	B	34	33	34	40	This discussion confuses the Gen. III, Gen. III+ and Gen. IV (GIF) concepts, and fails to clarify that the former two are much different from the last, and are the only ones concerning which current evidence of electric utility interest exists. It unrealistically conveys the prospect that the last are currently of interest to electricity companies (in reality they are largely national laboratory hobbies, and of little practical importance so far). Such unfounded technological optimism has been typical of much of the discussion of nuclear power for many years and does not contribute usefully to an understanding of how it can be practically beneficial. (Michael Golay, MIT)	Taken into account The boundary between GenIII, GenII+ is not strict. The concepts currently contemplated and being pre-licensed in USA contain some evolutionary features. Gen 4 is clearly under development yet, but this technology development is needed well in advance to be prepared for longer term requirements for enhanced efficiency in utilisation of uranium resources.
4-54	B	34	10	34	19	The text should be clear that most of the discussion of high level wastes is hypothetical, outlining what is planned – not what is reality. It reads as if what is being discussed is real. Further, the text is silent concerning implications of interim waste storage (the most practical option). Also, this discussion should address the implications for waste disposal and resource demands of greatly increased use of nuclear power. (Michael Golay, MIT)	Taken into account The text will be revised in the direction stating clearly that preparation for geological disposal is the realistic primary goal. The technology developed for P&T could provide additional safety margins by reducing the toxicity level of the wastes needing geological disposal.
4-55	B	35	0	35	5	Needs rewriting. (Michael Golay, MIT)	Taken into account The paragraph gives facts on ongoing international efforts. The status will be updated in SOD.
4-56	B	35	12	0	0	PBMR is not a Gen. IV concept. (Michael Golay, MIT)	Accepted PBMR is an innovative concept, although

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
							shorter-term option than the VHTR that belong to Gen4.
4-57	B	35	13	0	0	Intrinsic safety does not exist; "use of passive safety features" would be a more accurate phrase. (Michael Golay, MIT)	Accepted
4-58	B	35	39	0	0	intervention => intervention in energy markets. (Michael Golay, MIT)	This comment does not apply nuclear energy but section 4.3.3 on **renewable energy**
4-59	B	35	16	0	0	If the Gen. IV concepts are to be discussed seriously then the text should also be clear that their future prospects are at best questionable. To-date they are "vaporware", lacking any evidence of real industrial interest. (Michael Golay, MIT)	Taken into account Uncertain prospect will be mentioned. However strategic research, such as joint international efforts for Gen4, needs to be commenced as early as possible in spite of lower initial industrial/commercial interest.
4-60	B	35	24	0	0	commercial => practical. (Michael Golay, MIT)	Accepted.
4-61	B	36	13	36	16	The ocean energy concepts discussed here are a very mixed lot, varying to practical options to some with no hope (e.g., OTG). The text is needlessly confusing and fails to provide some guidance about which technologies to pay attention to. (Michael Golay, MIT)	Being rewritten – see Comments 722 - 724
4-62	B	36	50	0	0	The text should note that the renewables have free fuel, but are typically capital intensive, often due to the low power density of the solar source, and they are only partially dispatch able. (Michael Golay, MIT)	Not including Biomass? Eric to action
4-63	B	36	19	0	0	The text should note that hydro not only lacks support, it is usually opposed by "green" pressure groups. (Michael Golay, MIT)	Accept
4-64	B	37	28	37	39	The discussion of hydro fails to note that most hydro projects are opposed by someone; usually "green" pressure groups. In the developed world the set of suitable hydro sites is in almost complete use currently, and in developing countries where expansion is occurring (e.g., India, China) major social displacements as well as ecological disruptions are stimulating strong opposition – especially from human rights and "green" group in wealthy countries. Finally, the benefits of hydro – electricity production, irrigation resource creation and flood control are ignored; as are the destruction of previously existing riverine ecosystems, with replacement by those of large, semi-stagnant lakes. The latter add to evaporative water loss, snuffing out of many previously existing species and stimulation of new ones, some	Accept

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						of which have proven to be human parasites. However, hydro is one of the few industrial strength renewable technologies that can be deployed in a routine, straightforward fashion. (Michael Golay, MIT)	
4-65	B	37	1	37	10	Muddled para. the message is opaque. (Michael Golay, MIT)	Accept
4-66	B	38	25	38	29	What is meant is unclear. (Michael Golay, MIT)	Accept
4-67	B	38	39	38	45	This para. should be suppressed, as it advocates conversion of work into heat; the exact reverse of thermodynamically intelligent energy generation. (Michael Golay, MIT)	Being rewritten
4-68	B	38	37	0	0	The text fails to note that we have experienced a steady trend to taller towers and longer rotors, with accompanying steady growth of the aesthetically changed imposed by use of wind turbines. In the US this sometimes leads to opposition from abutters and others. (Michael Golay, MIT)	Accept
4-69	B	39	16	39	22	The implications of improvements in biotechnology for increasing the contributions of biomass fuels are ignored in the discussion of this section. These are potentially large and strongly beneficial. This possibility should be acknowledged, including the importance of supporting such developments financially. (Michael Golay, MIT)	Accept Bernhard
4-70	B	39	8	39	14	The discussion of biomass is silent about the occupational risks of producing and harvesting biomass fuels – among the most hazardous occupations practiced. It also fails to acknowledge the competition between land and water uses for food and energy production that would result in many places from heavy emphasis upon biomass for meeting bulk energy needs within the industrialized economies. This is already a problem in developing economies where the populations outside the cash economy typically rely substantially upon energy provided from scavenged biomass fuels, often with strong pressures on the local ecosystem resulting in substantial deforestation and habitat loss. (Michael Golay, MIT)	Accept. Being rewritten. Bernhard
4-71	B	40	0	42	0	Poorly written, should be redone. (Michael Golay, MIT)	Being revised. Accept
4-72	B	42	12	42	29	This discussion should pay more attention to whether the biofuels discussed provide net energy outputs, and where so whether the net values are truly large enough to make them attractive, practical options.	Being rewritten. Bernhard

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						(Michael Golay, MIT)	
4-73	B	43	28	43	29	The intended point is not clear. : (Michael Golay, MIT)	Accept. Bernhard
4-74	B	43	41	0	0	Acceptable to whom? (Michael Golay, MIT)	Accept
4-75	B	44	39	44	42	This para. is unhelpful, as it leads away from understanding what practical options exist. (Michael Golay, MIT)	Accept
4-76	B	44	24	0	0	Examples distinguishing between the opportunities and problems of geothermal and hot dry rock are needed; as these are not the same. (Michael Golay, MIT)	Accept
4-77	B	45	0	0	0	The discussion mixes the concepts of heat and work in a ways that merely contributes confusion. It needs a rewrite. (Michael Golay, MIT)	Being divided into solar electric and solar water heat
4-78	B	46	42	0	0	A summary of the promises and hurdles to be faced is needed. (Michael Golay, MIT)	Not new since TAR. Reject
4-79	B	47	0	0	0	Significant of what? (Michael Golay, MIT)	Cannot trace this one
4-80	B	63	3	63	3	Suggest to insert the following new paragraph: "The choice of policies and measures is not an easy task. It depends on many factors including costs, potential capacity, the extent to which emissions must be reduced, environmental and economic impacts, rates at which the technology can be introduced, and social factors such as public acceptance. Also, in the implementation of policies and measures governments need to give full consideration to actions to meet the specific needs and concerns of developing countries arising from the adverse effects of climate change and/or the impact of the measures on countries whose economies are highly dependent on income generated from the production, processing and export, and/or consumption of fossil fuels" (2,3) (2) United Nations Framework Convention on Climate Change. Article 4.8 (3) Kyoto Protocol. Article 3.2. There is no mention here of P&M baing adopted in developing countries such as China and India... This would seem to me to be important as it shows not only willingness to act but also what is practically feasable. Suggest a new paragraph starting in line 23, as follows: "Some developing countries as China and India have also adopted policies which show what is practically feasible at this stage" (Adnan Shihab-Eldin, OPEC)	Accepted, sentence inserted.
4-81	B	77	5	77	7	This paragraph needs to be amended. Actually, the quote by Karl and Gary, 2004,	Accepted, text changed.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Considerations by the writing team
						is as follows: "In the decade from 1984-1994, for example, OPEC members' share of annual military expenditures as a percentage of total central government expenditures was three times as much as the developed countries, and two to ten times that of the non-oil developing countries." (Adnan Shihab-Eldin, OPEC)	