INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Special Report on Renewable Energy Sources and Climate Change Mitigation

Expert Review of the First Order Draft
Dec 14, 2009 – Feb 8, 2010

Chapter 4

[1] *see <<http://ipcc.ch/pdf/ipcc-principles/ipcc-principles-appendix-a.pdf>>, Section 4.1 and clarification in decision 8 on procedures taken at the 33rd Session of the Panel <<http://www.ipcc.ch/meetings/session33/ipcc_p33_decisions_taken_procedures.pdf>>*

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Rybach (Geowatt AG)	4	0	-	-	-	-	-	-	Chapter 4 does not contain comments on chapter 10. A proper consideration of key messages and recommendations of chapter 4 needs to be ascertained in chapter 10.	Last part of Ch04 includes reference to modeled scenarios in Ch10.
Rybach (Geowatt AG)	4	0	-	-	-	-	-	-	No considerations are given to possible effects of global warming on geothermal resources. Whereas deep, thermal water-bearing aquifers could be effected presumably only on the long term, shallow aquifers could well be influenced by changing hydrologic cycles. Investigations along these lines are needed.	It will be included some comment on this issue in the SOD.
Vahrenholt (RWE Innogy GmbH)	4	0	-	-	-	-	-	-	The IPCC SRREN FOD details the main issues related to the global geothermal heat/cool and power production. Even if EGS systems have a very high potential, in the report the state of the art technologies should be given a higher priority. The text should be crossed-checked for a consistent use of units (EJ, GW, TWh).	Repeated with number 67.
Kammen (University of California, Berkeley)	4	1	1	-	-	-	-	-	I could not find reference to SWAC, salt water air conditioning, in the chapter. Given that this technology is in current deployment in Hawaii and in French Polynesia. Additional projects are underway in a number of locations in the South Pacific and in the Caribbean, it likely warrants discussion.	Those technologies are is not part of this chapter.
Pehnt (Institute for Energy and Environmental Research)	4	3	27	-	-	-	-	-	"""25-80 g/kWhe for binary plants"", must be ""23-80 g/kWhe"" as stated in section 4.5.2 line 38."	Done in Version 1A.
Pehnt (Institute for Energy and Environmental Research)	4	3	28	-	-	-	-	-	"""4-60 g/kWhth"" is not consistent with section 4.5.2, page 23, line 12 and 13. If the unit tonnes CO2-equivalent / TJ is converted into g CO2-equivalent / kWhth, it must be multiplied by 3.6."	It was changed in Version 1A.
Pehnt (Institute for Energy and Environmental Research)	4	3	14	-	-	-	-	-	"""Geothermal technologies are mature"" is not consistent with description in section 4.3.5 line 10 --> differentiate according to technology"	It was re-phrased in new Executive Summary (Ver 1A).
Outhred (University of New South Wales)	4	3	33	3	33	-	-	-	"Change ""competitive in the electric markets"" to ""competitive in some electricity markets"""	It was re-phrased in new Executive Summary (Ver 1A).
Outhred (University of New South Wales)	4	3	11	3	11	-	-	-	"Change ""sustainable development"" to ""sustainable process"""	Executive summary was changed in Version 1A.
Outhred (University of New South Wales)	4	3	9	3	9	-	-	-	"Change ""the tapped heat is continuously renovated"" to ""the tapped heat is continuously renewed"""	Executive summary was changed in Version 1A.
Bilello (NREL)	4	3	31	3	31	-	-	-	"I think ""Even"" should be ""Even though""?"	It was re-phrased in new Executive Summary (Ver 1A).
Outhred (University of New South Wales)	4	3	23	3	23	-	-	-	"Replace ""this year"" with ""2050"""	It was re-phrased in new Executive Summary (Ver 1A).
Bilello (NREL)	4	3	25	3	26	-	-	-	120 g/kWhe for flash, steam plants? Would be helpful to be more specific. Those not familiar with geothermal may think this is for all plants.	It is considered that the statement is quite clear referring to each type of plants.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Bilello (NREL)	4	3	25	3	27	-	-	-	Also are these values for operation only? If so, it may be useful to say so more clearly to distinguish from Line 27, which shows higher numbers for LCA values.	The sentence reads: "for currently operating... plants". It is considered clear enough.
Ferguson (St. Francis Xavier University)	4	3	43	-	-	-	-	-	Another reference to independence from climate that is not strictly true for shallow and low temperature resources.	Some comment will be included in SOD.
Ferguson (St. Francis Xavier University)	4	3	12	3	13	-	-	-	It is not entirely true that geothermal resources will not be impacted by climate change. Majorowicz et al. (2009, Natural Resources Research 18(2): 95-108) show heat gain in the upper 250 m of the Earth's crust has already had a noticeable effect on temperature files in the context of heat pumps and direct use applications.	It will be included some comment on this issue in the SOD.
Abed (National Research Centre)	4	3	38	-	-	-	-	-	Omit in before despite	Done in Version 1A.
Abed (National Research Centre)	4	3	32	-	-	-	-	-	put kW instead of megawatt	Done in Version 1A.
Abed (National Research Centre)	4	3	44	-	-	-	-	-	serves	Verb serve is following verb can, so it's infinitive
Rybach (Geowatt AG)	4	3	22	-	23	-	-	-	the estimate of 3 % geothermal coverage of global electricity demand in year 2050 is nice, but what number was assumed for the global demand?	It was used the same projections of Chapter 10 (see tables).
Outhred (University of New South Wales)	4	3	34	3	35	-	-	-	US$/MWh - indicate dollars of what year (eg US$ (2005)	It is indicated that are 2005 US$.
LEITE DRACHMANN (PETROBRAS)	4	3	12	3	13	Executive Summary	-	-	Climate changes must interfere in geothermal resources since it would increase the cold source temperature (ambient temperature), decreasing the useful energy, For instance in Alaska resources with 73o C could be convert to electricity, but in the continental USA, this is possible only with higher geofluids temperature.	It will be included some comment on this issue in the SOD.
LEITE DRACHMANN (PETROBRAS)	4	3	43	3	43	Executive Summary	-	-	instead of climate is preferable weather	It was re-phrased in new Executive Summary (Ver 1A).
Abed (National Research Centre)	4	4	5	-	-	-	-	-	"rock as ; omit and"	Resources can be rock AND trapped steam or liquid water.
de Campos (Petrobras)	4	4	26	4	32	-	-	-	Exclusion.The paragraph is very confused and its suppression would not affect the overall comprehension of the theme.	It was considered that this paragraph must remains.
de Campos (Petrobras)	4	4	4	5	39	-	-	-	For power proposes, is very confused all the explanation.In matter of fact there are 2 kinds of geothermal resources able to generate electricity: the conventional ones in operation in about 24 countries around the word, producing hot water above 2000m deep, with temperatures above 150o C. The unconventional resources lies bellow those hydrothermal reservoirs, and correspond to the hot and dry rock unlocked by EGS techniques. In another part this distinction is made.	It will be clarified in SOD.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
de Campos (Petrobras)	4	4	34	4	34	-	-	-	Instead of hydraulic ☐pressure☐, hydraulic fracturing is preferable as it is the usual name of this stimulation practices.	Done.
Rybach (Geowatt AG)	4	4	2	-	-	-	-	-	Replace the last two sentences by ☐This is the challenge as well as the opportunity☐.	It was re-phrased in new Executive Summary (Ver 1A).
Williamson (Chevron Corporation)	4	4	13	4	13	-	-	-	Some aspects of geothermal technology are mature, others (EGS, logging, MWD) are not, especially when compared to oil and gas.	It was re-phrased in new Executive Summary (Ver 1A).
Williamson (Chevron Corporation)	4	4	33	4	33	-	-	-	The expected cost of EGS is highly dependent on the local geothermal gradient, so it would be better to use a range.	It was used a range in Version 1A.
de Campos (Petrobras)	4	4	7	4	9	-	-	-	There is no explanation to the temperature limits of geothermal resources considered by the authors. It is in disagreement with, for example the USGS recommendation (Williams, Reed and Mariner 2008) for the assessment of moderated to high temperatures that take 90o C to the lower limit to geothermal power in USA condition, with exception of Alaska, where geothermal power is possible with 73o C, since the cold source is only 7o C.	Repetead with comment 8.
LEITE DRACHMANN (PETROBRAS)	4	4	26	4	32	4.1	-	-	Exclusion.The paragraph is very confused and its suppression would not affect the overall comprehension of the theme.	Repeated with number 9.
LEITE DRACHMANN (PETROBRAS)	4	4	4	5	39	4.1	-	-	For power proposes, is very confused all the explanation.In matter of fact there are 2 kinds of geothermal resources able to generate electricity: the conventional ones in operation in about 24 countries around the word, producing hot water above 2000m deep, with temperatures above 150o C. The unconventional resources lies bellow those hydrothermal reservoirs, and correspond to the hot and dry rock unlocked by EGS techniques. In another part this distinction is made.	Repeated. Same comment as 14.
LEITE DRACHMANN (PETROBRAS)	4	4	34	4	34	4.1	-	-	Instead of hydraulic ☐pressure☐, hydraulic fracturing is preferable as it is the usual name of this stimulation practices.	Repeated with number 10
LEITE DRACHMANN (PETROBRAS)	4	4	7	4	9	4.1	-	-	There is no explanation to the temperature limits of geothermal resources considered by the authors. It is in disagreement with, for example the USGS recommendation (Williams, Reed and Mariner 2008) for the assessment of moderated to high temperatures that take 90o C to the lower limit to geothermal power in USA condition, with exception of Alaska, where geothermal power is possible with 73o C, since the cold source is only 7o C.	There are several temperature limits to "high" and "low" resources. We adopted one of those limits which are not necessary coincident with that reference.
Bilello (NREL)	4	4	15	4	24	-	-	4.1	"Lines 15-21 list the three types as convective, conductive and lower temperature; the Table lists hydrothermal, cocnductive an lower temperature. A bit confusing."	It was included the word "Convective" in Table 4.1.
Sims (Massey University)	4	4	-	-	-	-	-	4.1	Other chapters use M Medium, not I intermediate.	In this chapter it seems preferable to use intermediate.
Fridleifsson ()	4	4	41		42				Look very carefully at cost numbers, especially for EGS. I do not believe that EGS can have lower price than best natural hydrothermal systems.	To be changed in SOD

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Bilello (NREL)	4	5	6	5	6	-	-	-	"""Stacked geothermal sub-types (plays) are common."" May want to explain what this means - the RE community may not be familiar with these O&G terms."	Sentence was omitted in Version 1A.
Bilello (NREL)	4	5	26	5	27	-	-	-	"here you say capacity factor is up to 90%; page 3, line 18 has average of 77%. May want to clarify someplace."	It was added "in some plants" in Version 1A.
Outhred (University of New South Wales)	4	5	42	5	42	-	-	-	50 EJ/year	The exact quote (as published) is 50 EJ, not 50 EJ/y.
Abed (National Research Centre)	4	5	14	5	14	-	-	-	can be omitted	The paragraph is considered important.
Abed (National Research Centre)	4	5	44	5	45	-	-	-	rearrange: an available energy resource for □□□□.EJ/Year was estimated	The sentence was deleted in Version 1A, since 5000 EJ/y is too high.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	5	8	-	-	-	-	-	The reference by Goldstein, 2010 does not exist in the REFERENCES, however, Goldstein et al., 2010 does exist.	Check-out reference (as a matter of fact, it is necessary to check all of them).
de Campos (Petrobras)	4	5	27	5	27	-	-	-	There is a huge confusion with the Capacity Factor. In the Executive Summary CF is referred as 70%, in this line is □up to 90%□. But in the item 4.7.3, page 33, line 4 until line 12, there is an explanation about those diverse values to CF. Unfortunately, there is a table on precedent item (table 4.4, item 4.4.1 line 17 to 20, and page 16) that shows this variability but without any link between them	CF was rephrased in Executive Summary, and it was added a paragraph in subsection 4.7.4 (where was moved the table 4.4). The current worldwide average CF is 71%.
Williamson (Chevron Corporation)	4	5	11	5	11	4.1	-	-	Only in Italy has geothermal been operating for 100 years	That is clear in the previous paragraph.
LEITE DRACHMANN (PETROBRAS)	4	5	27	5	27	4.1	-	-	There is a huge confusion with the Capacity Factor. In the Executive Summary CF is referred as 70%, in this line is □up to 90%□. But in the item 4.7.3, page 33, line 4 until line 12, there is an explanation about those diverse values to CF. Unfortunately, there is a table on precedent item (table 4.4, item 4.4.1 line 17 to 20, and page 16) that shows this variability but without any link between them	Repeated with number 15.
MANNEH (MINISTRY OF FINANCE AND ECONOMIC AFFAIRS)	4	5	42	8	30	4.2.1	-	-	The Chapter could be shortened from these ranges or areas without affecting the substance	It will be considered in SOD.
Fridleifsson ()	4	5	14		14				Add hydro to the list (hydro, wind and solar).	Done in Version 1A.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Blankenship (Sandia National Laboratories, New Mexico)	4	6	41	6	44	-	-	-	"Discussion of heat resource in the ocean ridges quotes cited work assumptions of 1% developed with 4% recovery. These ☐low numbers☐ are used by all of the renewable technologies (and not the only example in this chapter). With 3900 km of confirmed high temp ocean ridge locations, is it reasonable to think that some 40 km would actually be developed at any foreseeable time? I don't know but these ""low"" numbers are thrown around all the time without justification other than 1% sounds low."	Chapter 4 considers necessary to include hydrothermal vents as another option of geothermal energy.
Rosinski (Electric Power Research Institute)	4	6	31	-	-	-	-	-	"EPRI citation listed as ""ESPRI"""	Done in Version 1A.
de Campos (Petrobras)	4	6	41	6	44	-	-	-	"Suggestion of exclusion. The geothermal submarine resources linked to oceanic ridge is more an author☐s guess than a technological possibility, even in the long term. Most of the oceanic ridges are located on very deep waters and very far from the coast; even we do have any kind of successful conversion, transmitting it to cities will be almost impossible and very expensive."	Chapter 4 considers necessary to include hydrothermal vents as another option of geothermal energy.
Blankenship (Sandia National Laboratories, New Mexico)	4	6	-	-	-	-	-	-	Authors provide resources in terms of EJ, TWt, Gwe ... Reader will have a hard time following	Equivalences of units have been included wherever it was possible.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	6	31	-	-	-	-	-	Check language.	Done in Version 1A.
Kutscher (National Renewable Energy Laboaratory)	4	6	18	-	-	-	-	-	One characteristic of geothermal resources is that there is a lot of uncertainty. The most recent USGS study gave a range with different probabilities. This report is just giving the mean. It is important to give the range so that the uncertainty is clear to the reader.	In further paragraphs are indicated the ranges: low, medium, high.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	6	30	-	-	-	-	-	Should the reference by Goldstein, 2010 be Goldstein et al., 2010?	Check-out reference (as a matter of fact, it is necessary to check all of them).
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	6	12	-	-	-	-	-	Specify depth of the theoretical potential. In this paragraph, reference is made to depths of 10,000 m and 5,000 m.	Paragraph will be rephrased in SOD.
Outhred (University of New South Wales)	4	6	7	6	7	-	-	-	Terrestial heat flow of 1400 EJ/yr does not seem consistent with 5000 EJ/yr resource estimate on previous page (5)	Estimation of 5000 EJ/y was taken for table 4.2 of AR4. But the previous sentence is now deleted in Version 1A.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	6	31	-	-	-	-	-	The cited reference should be EPRI, 1978, not ESPRI, 1978.	Done in Version 1A.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Bilello (NREL)	4	6	16	6	18	-	-	-	USGS is different from MIT-led estimate because of (1) differnce in geographic region (captured in paper & (2) differences in depth ranges (not mentioned in your paper) - may be useful to identify the USGS depth range to be 3-6 km.	Paragraph will be rephrased in SOD.
LEITE DRACHMANN (PETROBRAS)	4	6	41	6	44	4.2	-	-	"Exclusion. The geothermal submarine resources linked to oceanic ridge is more an author□s guess than a technological possibility, even in the long term. It is like using the energy of lightings of a storm or the winds of a hurricane: there is a huge amount of energy but there isn□t technology to covert it to useful electricity.Most of the oceanic ridges are located on very deep waters and very far from the coast; even we do have any kind of successful conversion, transmitting it to cities will be almost impossible and very expensive."	Chapter 4 considers necessary to include hydrothermal vents as another option of geothermal energy.
Kleidon (Max-Planck-Institute for Biogeochemistry)	4	6	30	6	35	4.2.1	-	-	"At the end of this paragraph it is stated that ""both estimates are conservative in the context of sustainable level for development"". The numbers stated are referring to the ""mining"" , I.e. depletion of the heat content of the continental crust. This is not sustainable. Sustainable rates of geothermal heat are limited by the geothermal heat flux, which is not more than 315 EJ/yr on continents. It is important to clarify this in the text."	The paragraph was shortened and rephrased in Version 1A.
Williamson (Chevron Corporation)	4	6	42	6	42	4.2.1	-	-	"The reference does not give any justification for 5000 EJ/yr, and this number seems inconsistent with the 50 EJ ""likely cumulative potential by 2030"". 5000 EJ/yr is equivalent to 230 million MW!"	The previuos paragraph on 5000 EJ/y (from AR4) was deleted.
Kleidon (Max-Planck-Institute for Biogeochemistry)	4	6	8	6	13	4.2.1	-	-	"This section combines the heat content of 5 km crust with the mean geothermal heat flux to state a number of 42 * 10^6 EJ as the theoretical potential. How does this work, combining a heat reservoir with a flux? Depleting the heat content within one year is clearly technologically impossible and therefore this cannot be the annual mean ""theoretical potential""!"	The theoretical potential is not the potential that can be obtained in one year, since the units are EJ, not EJ/y.
Williamson (Chevron Corporation)	4	6	39	6	42	4.2.1	-	-	Since the origin of these numbers is not clear, and their relationship to the paragraphs that follow is not stated, I suggest this paragraph be removed.	Partially acceptable. Paragraph will be rephrased in SOD.
Rybach (Geowatt AG)	4	7	10	-	-	-	-	-	Add □Technology development like faster drilling can increase with time the technical potential□.	Done in Version 1A.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	7	19	-	-	-	-	-	Reference by Fridleifsson et al., 2009 does not exist in the REFERENCES.	Check-out reference (as a matter of fact, it is necessary to check all of them).
Williamson (Chevron Corporation)	4	7	37	7	37	4.2.1	-	-	130 is too precise for this type of speculative resource. >100 is more appropriate.	Done in Version 1A.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Williamson (Chevron Corporation)	4	7	26	7	28	4.2.1	-	-	There is insufficient experience with EGS to justify recovery factors. I think this kind of analysis is premature. Also, the reference is not available yet □ and as a conference paper it may not be peer-reviewed.	The recovery factors are transparent and come from reservoir assessment models like TOUGH2. Reference will be available soon.
Fridleifsson ()	4	7	25		27				Replace "along" with "through" and "over" with "throughout".	Done in Version 1A.
Fridleifsson ()	4	7	7		7				Replace "started" by "has been practiced"	Done in Version 1A.
Abed (National Research Centre)	4	8	14	-	-	-	-	-	Accountingly,	Paragraph was rephrased in Version 1A
Bilello (NREL)	4	8	14	8	16	-	-	-	if the realistic range is 90-130 Gwe by 2050, why is half of the maximum 160GWe? Not sure if there is a typo or if I'm misunderstanding, but this should be corrected or made more clear.	Paragraph was rephrased in Version 1A
Abed (National Research Centre)	4	8	14	8	16	-	-	-	numbers contradiction	Paragraph was rephrased in Version 1A
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	8	24	-	-	-	-	-	Order cited references by year or alphabetical order.	Done in Version 1A.
Williamson (Chevron Corporation)	4	8	13	8	13	4.2.1	-	-	The WGC paper by Bromley et al 'Contribution of Geothermal Energy to Climate Change Mitigation: the IPCC Renewable Energy Report' propose 170 Gwe, not 160. As noted above numbers in Chapter 4 and this paper need to be reconciled.	We will define the basis for the calculation in the SOD, and will use the number that it gets.
Blankenship (Sandia National Laboratories, New Mexico)	4	9	23	9	23	-	-	-	"Need to explain what a ""doublet system"" is."	Add short explanation.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	9	25	-	-	-	-	-	Check language: After production stops, recharge begins□.. ?	Paragraph was rephrased in Version 1A
Abed (National Research Centre)	4	9	25	-	-	-	-	-	recharge begines	Paragraph was rephrased in Version 1A
Williamson (Chevron Corporation)	4	9	7	9	14	4.2.1	-	-	A statistical analysis based on recovery factors for which there is no experience is not a valid tool for resource estimation.	In the case of EGS resources, statistical is a good tool for estimation.
Williamson (Chevron Corporation)	4	9	1	9	6	4.2.1	-	-	Remove this paragraph to improve readability	It is not clear what paragraph is this.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	TOTAL 22.075	All figures were updated according to John Lund inputs in new Table 4.2.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	A general remark to the Table: showing four significant digits is, in view of the uncertainties, illusory. Rounding is needed.	Figures were rounded.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	Africa 0.325	All figures were updated according to John Lund inputs in new Table 4.2.

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Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	China 4.063	All figures were updated according to John Lund inputs in new Table 4.2.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	Developing Asia 0.271	All figures were updated according to John Lund inputs in new Table 4.2.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	India 0.325	All figures were updated according to John Lund inputs in new Table 4.2.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	J. Lund (GeoHeatCenter, Klamath Falls/USA, Contributing Author) supplied new numbers for column 5:	All figures were updated according to John Lund inputs in new Table 4.2.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	Latin America 0.542	All figures were updated according to John Lund inputs in new Table 4.2.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	Middle East 0.433	All figures were updated according to John Lund inputs in new Table 4.2.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	OECD Europe 8.126	All figures were updated according to John Lund inputs in new Table 4.2.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	OECD North America 6.230 EJ/yr	All figures were updated according to John Lund inputs in new Table 4.2.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	OECD Pacific 1.354	All figures were updated according to John Lund inputs in new Table 4.2.
Rybach (Geowatt AG)	4	9	-	-	-	-	-	4.2	Transition Economies 0.406	All figures were updated according to John Lund inputs in new Table 4.2.
Fridleifsson ()	4	9	18		18				Replace "Fridleifsson et.al., 2009" with "Fridleifsson et.al., 2008"	Done in Version 1A.
Kutscher (National Renewable Energy Laboaratory)	4	10	26	-	-	-	-	-	"""Dry"" or superheated steam reservoirs are quite rare: Lardarello in Italy and The Geysers in the U.S. are the only two I know of, although The Geysers is a large (but declining) resource"	Word "some" changed to "few".
Ferguson (St. Francis Xavier University)	4	10	3	10	7	-	-	-	Again, climate change.	It will be included some comment on this issue in the SOD.
Abed (National Research Centre)	4	10	5	-	-	-	-	-	change efficiency to be coefficient of performance	Sentence was omitted in Version 1A.
Blankenship (Sandia National Laboratories, New Mexico)	4	10	41	10	43	-	-	-	How are estimates of temperature and in situ stress used to determine the potential for fluid bearing structures.	It will be included some explanation.
de Campos (Petrobras)	4	10	26	10	26	-	-	-	It is better using □few□ than some as dry steam is only found at Lardarello and The Geysers	Word "some" changed to "few".
Bilello (NREL)	4	10	6	10	7	-	-	-	many hydrothemral plants in U.S. are already air-cooled because they are in water-scarce areas. Also, the U.S. geothemral supply curve is based on air-cooling. Perhaps mention that air-cooling for geoethermal is already common in some areas.	Sentence was omitted in Version 1A.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
de Campos (Petrobras)	4	10	13	10	19	-	-	-	Williams, Reed and Mariner (2008) use other temperature limits to classifying geothermal resources. According to those authors high temperature is over 150o C and moderate temperature from 90o C to 150o C. There are at least 7 geothermal commercial plants in operation in 2005 (Bertani 2005) that operates with temperature bellow 180o C.	There are several temperature limits to "high" and "low" resources. We adopted one of those limits which are not necessary coincident with that reference.
Williamson (Chevron Corporation)	4	10	30	10	32	4.2.3	-	-	Ambient temperature and humidity can affect the efficiency of geothermal power plants, especially air-cooled binary plants.	Sentence included in Version 1A.
Williamson (Chevron Corporation)	4	10	29	10	29	4.2.3	-	-	Axelsson and Bromley, 2008 reference is missing	Reference included in Version 1A.
LEITE DRACHMANN (PETROBRAS)	4	10	26	10	26	4.3.1	-	-	It is better using □few□ than some as dry steam is only found at Lardarello and The Geysers	Repeated with comment 76.
LEITE DRACHMANN (PETROBRAS)	4	10	13	10	19	4.3.1	-	-	Williams, Reed and Mariner (2008) use other temperature limits to classifying geothermal resources. According to those authors high temperature is over 150o C and moderate temperature from 90o C to 150o C. There are at least 7 geothermal commercial plants in operation in 2005 (Bertani 2005) that operates with temperature bellow 180o C.	Repetead with comment 75.
Williamson (Chevron Corporation)	4	10	25	10	25	-	-	4.2.3	Actual behavior of systems after shut-in is unknown - comments are based on modeling results	To be considerd in S.O.D
Outhred (University of New South Wales)	4	11	44	11	46	-	-	-	"""About 15 back-pressure units of 5 MWe have been successfully operating in Mexico since the 1980s"". Provide reference"	Reference included in Version 1A.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	11	6	-	-	-	-	-	Check language: Typically, wells are deviated from the vertical□?	Apparently, phrasing is correct.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	11	3	-	-	-	-	-	Reference by Zui, 2010 does not exist in the REFERENCES.	Reference was deleted.
Blankenship (Sandia National Laboratories, New Mexico)	4	11	14	11	14	-	-	-	To say that today geothermal wells are drilled to 5 km is a bit disingenuous, only a handful of geothermal wells have been drilled to that depth and I do not know any that were drilled to that depth as part of a commercial development.	Depth changed to a rqnge. There are several wells in Cerro Prieto around the new range.
Williamson (Chevron Corporation)	4	11	4	11	6	4.3.1	-	-	Intermediate temperature resources are found in a wide range of geological environments.	Paragraph was rephrased in Version 1A
Williamson (Chevron Corporation)	4	11	20	11	21	4.3.1	-	-	Only hydrothermal technology is mature, not EGS. This paper should attempt to describe the level of maturity rather than refer to a conference held 6 years ago.	The reference was used only to integrate geothermal technology in categories defined by that conference held 6 years ago.
Williamson (Chevron Corporation)	4	11	32	11	32	4.3.2	-	-	DC Resistivity methods have been replaced by electromagnetic methods	Paragraph was rephrased in Version 1A

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Williamson (Chevron Corporation)	4	11	32	11	32	4.3.2	-	-	Seismic methods have been largely ineffectice in hydrothermal exploration, and are rarely used.	Paragraph was rephrased in Version 1A
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	11	11	11	30	4.3.3	-	-	I suggest to add the reference : Grant, M.A., I.G., Donaldson, and P.F. Bixley, Geothermal reservoir engineering. Academic Press, New York, 1982.	Reference was added in Version 1A.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	11	35	11	36	4.3.4	-	-	Add contact to read 'direct contact condenser'.	Included in Version 1A.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	11	36	11	37	4.3.4	-	-	Sentence unclear. ' steam condensate is lost to the atmosphere as vapour'. Steam condensate is in liquid phase. Can you loose it as vapour?	Sentence was deleted in Version 1A.
Williamson (Chevron Corporation)	4	12	19	12	32	4.3.4	-	-	"To avoid confusion, the difference between ""flash"" plants and binary plants should be described at the beginning of this paragraph."	Paragraph was rephrased in Version 1A
Williamson (Chevron Corporation)	4	12	28	12	28	4.3.4	-	-	Back pressure units represent a tiny fraction of global installed capacity. Not worth describing in detail.	Paragraph was rephrased in Version 1A
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	12	8	12	10	4.3.4	-	-	Combined or hybrid power plants comprise two or more of the above basic types□ i.e., steam, flash and binary cycles. Since binary cycle plants are included in combined or hybrid plants, according to the previous paragraph, hence the temperature range should be 90 -260□C.	Done in Version 1A.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	12	1	12	3	4.3.4	-	-	The typical temperature range for Binary cycle plants 90-170□C. The Alaska power plant is an exceptional case of this technology due to unique ambient conditions of that plant.	We are talking about a general rank, and this includes the Alaska plant.
de Campos (Petrobras)	4	13	8	13	9	-	-	-	"There isn't any EGS for direct heating; its first goal is to electric power. It can be associated to direct use, but it is hard to believe that anyone would drill and stimulate hot dry rocks just for heating proposes"	The comment is right. Sentence was rephrased in Version 1A.
de Campos (Petrobras)	4	13	20	14	15	-	-	-	Exclusion. See previous comment	See previous paragrapgh.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	13	11	-	-	-	-	-	I suggest to modify this sentence to read '□..will be to achieve and maintain efficient and reliable'□.	Word added in Version 1A.
de Campos (Petrobras)	4	13	13	13	13	-	-	-	Include □and reducing seismicity risks□	Repeated with comment 66.
LEITE DRACHMANN (PETROBRAS)	4	13	8	13	9	4.3.5	-	-	"There isn't any EGS for direct heating; its first goal is to electric power. It can be associated to direct use, but it is hard to believe that anyone would drill and stimulate hot dry rocks just for heating proposes"	Repeated with comment 65.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
LEITE DRACHMANN (PETROBRAS)	4	13	13	13	13	4.3.5	-	-	Include ☐and reducing seismicity risks☐	Added in Version 1A.
LEITE DRACHMANN (PETROBRAS)	4	13	20	14	15	4.3.6	-	-	Exclusion. See previous comment	Repeated with comment 63.
LEITE DRACHMANN (PETROBRAS)	4	13	18	13	19	4.3.5	-	4.3	This is not a table, as there isn't any relationship between the rows, there is just one row	Chapter 4 does not share the opinion of this reviewer.
Outhred (University of New South Wales)	4	14	1	14	1	-	-	-	"""but there is others"" change to ""but there are others"""	"is" changed to "are".
Bilello (NREL)	4	14	2	14	25	-	-	-	"""fossil fuel backup"" - may not be fossil fuel. If house has electric heating, electricity can come from renewable resources. Perhaps just use ""back up"" or ""traditional heating back-up"" or the like."	Word "conventional" was used instead of fossil fuel.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	14	1	-	-	-	-	-	Check language: '☐.. (Lupton, 1995) but there is (or are) others☐'.	"is" changed to "are".
Williamson (Chevron Corporation)	4	14	12	14	20	4.3.6	-	-	Inappropriate to dedicate space to engineering concepts when economics are key here.	Chapter 4 considers necessary to include hydrothermal vents as another option of geothermal energy.
Williamson (Chevron Corporation)	4	14	5	14	22	4.3.6	-	-	The economics of submarine generation need to me mentioned here, since that may be the greatest hurdle. A vent discharging 60 MWt could likely produce no more than 15 Mwe, which could never justify a long undersea cable.	Chapter 4 considers necessary to include hydrothermal vents as another option of geothermal energy.
Williamson (Chevron Corporation)	4	14	-	-	-	-	-	4.3	Several items in this table are not research e.g. reserve definitions, education. I suggest drawing on US DOE initiatives for EGS research priorities.	Title in table was changed.
Bilello (NREL)	4	15	12	15	12	-	-	-	"""☐ then discharges it into another well or to surface."" maybe add ""water (lake or pond)"" ☐ it's not clear as it is."	Rephrased in Version 1A.
Ferguson (St. Francis Xavier University)	4	15	4	-	-	-	-	-	"4 to 30C water is not necessarily available everywhere. There are large areas in subpolar and polar regions that where subsurface temperatures will be below 4 C to significant depths. This may not represent a huge population of people and will not likely have a large effect on the amount of GHG emissions that could be mitigated. However the statement is relatively easy to fix with by changing the statement to read ""readily available almost everywhere..."" "	Words added in Version 1A.
Abed (National Research Centre)	4	15	13	-	-	-	-	-	"Omit""that are reversed"" and add:""with the heat rejected in the condencer is used for heating"" "	Sentence added in Version 1A.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
de Campos (Petrobras)	4	15	25	15	26	-	-	-	The distinction between conventional and unconventional development, like EGS/HDR, must be used on Executive Summary and in all other item that classifies geothermal resources. The complete reference to Williams, Reed and Mariner (2008) is Williams, C.F., Reed, M.J., and Mariner, R.H., 2008, A review of methods applied by the U.S. Geological Survey in the assessment of identified geothermal resources: U.S. Geological Survey Open-File Report 2008-1296, 27 p. [http://pubs.usgs.gov/of/2008/1296/]	Distinction was included here because the market/industry is analized in those general areas. There are no reference to William et al. 2008.
LEITE DRACHMANN (PETROBRAS)	4	15	25	15	26	4.4	-	-	The distinction between conventional and unconventional development, like EGS/HDR, must be used on Executive Summary and in all other item that classifies geothermal resources. The complete reference to Williams, Reed and Mariner (2008) is Williams, C.F., Reed, M.J., and Mariner, R.H., 2008, A review of methods applied by the U.S. Geological Survey in the assessment of identified geothermal resources: U.S. Geological Survey Open-File Report 2008-1296, 27 p. [http://pubs.usgs.gov/of/2008/1296/]	Repeated with comment 19.
Pehnt (Institute for Energy and Environmental Research)	4	16	6	-	-	-	-	-	"""high temperature"" must be accompanied with ""intermediate temperature"", because for example Germany has only <180 degrees Celcius geothermal resources in 2009."	"high temperature" was removed in Version 1A.
Gagnon (Hydro-Quebec)	4	16	-	-	-	-	4.6	-	figure too busy with too small prints	It will be improved.
Gagnon (Hydro-Quebec)	4	16	-	-	-	-	-	4.4	Suggest that energy units be converted in TWh/yr instead of GWh/yr	Units are in GWe of installed capacity, no electricity generation (GWh/y)
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	16	-	-	-	4.4.1	-	4.4	Horizontally center the data in column 3.	Note: This table was moved and now is Table 4.7 in Version 1A.
Fridleifsson ()	4	16	16		16				"Up to 25 km" is not correct. The maximum er 63 km.	Done in Version 1A.
Abed (National Research Centre)	4	17	24	-	-	-	-	-	"Global installed=11 Gwe from table 4.4 year 2010; US=4249 MW, US= 4249/11000=38.6%, rest=61.4%, 65% of the rest= 61.4x 0.65 = 40% of Global "	Global installed capacity is 10.7 GW; in US there are 3.09 GW (Fig. 4.6). Then 3.09/10.7 = 28.87%.
LEITE DRACHMANN (PETROBRAS)	4	17	4	17	4	4.4.1	-	-	In matter of fact the commercial production of geoelectricity was only achieved at 1913, nine years after the 1904 demonstration	That's correct. No further action is necessary.
Williamson (Chevron Corporation)	4	17	13	17	13	4.4.1	-	-	Stephure, 2009 is an analyst report not subject to peer review, and unsuitable for this Chapter.	Reference was deleted and paragraphs were rephrased in Version 1A.
Pehnt (Institute for Energy and Environmental Research)	4	18	21	-	-	-	-	-	"""In Landau...fall 2007."" The geothermal plant in Landau is not a EGS concept, but a hydrothermal one (3000m depth)."	The Landau project is within the continuum of geothermal between a low permeabilty (hot dry rock) and high grade hydrothermal resource.
Outhred (University of New South Wales)	4	18	17	18	18	-	-	-	"""Project developers plan to establish the first power plants (with a few MWe capacity) in 2010 (Beardsmore, 2007)."" These Australian installations may be delayed"	Sentence was removed in Version 1A.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Abed (National Research Centre)	4	18	4	18	5	-	-	-	"to be corrected by the author; detailed information may be found in: www.IEA-GIA.org "	Information is updated in Version 1A.
Abed (National Research Centre)	4	18	17	-	-	-	-	-	2010 should be corrected	Sentence was removed in Version 1A.
Sims (Massey University)	4	18	10	-	26	-	-	-	Swiss plant shut down and legal questions underway. This should be reported.	We added a comment in section 4.5.3.
Williamson (Chevron Corporation)	4	18	15	18	23	4.4.2	-	-	"Drilling activity and plant construction should be used as an indicator of ""large scale activity"", not leasing and small company registration."	Paragraph was rephrased.
Williamson (Chevron Corporation)	4	18	3	18	5	4.4.2	-	-	"I suggest the following: ""If the EGS demonstration projects are successful, EGS development is expected to produce substantial environmental benefits through the generation of CO2-free electric power"""	The complete paragraph was deleted, according to a TSU suggestion (it had no relation to market or industry situation.
Abed (National Research Centre)	4	19	11	-	-	-	-	-	"add:""36% direct and 16% from heat pumps"""	Sentence was rephrased in Version 1A, since the TSU pointed out something similar to this comment.
Abed (National Research Centre)	4	19	5	-	-	-	-	-	"add:""with respect to emmisions reduction"""	Paragraph was deleted in Version 1A.
Blankenship (Sandia National Laboratories, New Mexico)	4	19	7	19	18	-	-	-	"It is curious that they include geothermal heat pumps with direct use, especially when they note that ""only a small degradation of the thermodynamic quality of the geothermal heat occurs"". I think this is distinctly different that running hot water directly to a building or a pond of fish. Why not a separate section on heat pumps?"	The chapter 4 team will ask to JL and LR about their opinion. A subsection 4.4.4: Status of GHP will be added.
Outhred (University of New South Wales)	4	19	6	19	6	-	-	-	CO2 benefits will depend on the emissions of the generators that are displaced by the geothermal generator, which will be context-specific.	Paragraph was deleted in Version 1A.
Kutscher (National Renewable Energy Laboaratory)	4	19	3	-	-	-	-	-	This should be explained. There is uncertainty in the EGS resource and there are technical and economic challenges to overcome in tapping that resource. (But there is very large potential for producing steady, base load power.)	Paragraph was deleted in Version 1A.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	19	15	15	18	4.4.3	-	-	. I suggest to add the paragraph: 'Heat pumps have been operated at the Los Azufres and Cerro Prieto geothermal fields with low-pressure geothermal steam and separated water to produce distilled water from geothermal brines, and ice and cold storage at -13□C (Garcia-Gutierrez, et al, 2010). The full reference is: Garcia-Gutierrez, A. R. M. Barragan-Reyes, V. M.. Arellano-Gomez, Research and development on heat pump systems in Mexico using geothermal Energy, Current Applied Physics, in press, 2010 This reference should be placed in the References section after the reference by Galantaterm, 2007.	The suggested example is too detailed for this report.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Bilello (NREL)	4	20	37	20	39	-	-	-	DOE research is focused primarily on rersevoir engineering and innovative exploration technologies http://www.energy.gov/news2009/documents2009/338M_Geothermal_Project_Descriptions.pdf	Yes, but also is supporting EGS investigation.
Rybach (Geowatt AG)	4	21	-	-	-	-	-	-	Section 4.5 □Environmental and social impacts□: social impacts are practically not treated.	Some comments on this issue will be added in SOD.
Outhred (University of New South Wales)	4	21	10	21	11	-	-	-	"""can, and has been, a useful incentive"" provide reference"	"has been" was deleted in Version 1A.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	21	44	-	-	-	-	-	Check language: When the extracted geothermal fluid is passed□..	"the" included in Version 1A.
Blankenship (Sandia National Laboratories, New Mexico)	4	21	33	21	46	-	-	-	Relative to CO2 and other emissions they discuss high-temperature (>180 C) and low temperature (<100 C) resources but there is not discussion on intermediate temperature resources which are largely binary systems with virtually no emissions. Intermediate resources need to be discussed.	Paragraph addressing low temperature is actually referring to intermediate temperature too. So, it was pointed out in Version 1A.
Budd (Geoscience Australia)	4	21	1	16	-	-	-	-	requires reworking.	It will be improved in SOD.
Williamson (Chevron Corporation)	4	21	21	21	21	4.5.1	-	-	Hydrocarbon gases, mainly methane, typically are a few percent of gases by volume.	Accepted
Williamson (Chevron Corporation)	4	21	37	21	38	4.5.1	-	-	This section should discuss emissions from geothermal plants. Avoided emissions by heat pumps are not appropriate here.	To be changed in S.O.D
Williamson (Chevron Corporation)	4	22	22	22	23	4.5.2	-	-	Closed loop binary plants represent a small fraction of the global installed capacity, and have a much lower LCA than the global average for geothermal plants, which are mainly flash plants. This needs to be made clear in the text.	A sentence was added in Version 1A.
Fridleifsson ()	4	22	25		25				Add reference: Fridleifsson et.al., 2008.	Done in Version 1A.
Abed (National Research Centre)	4	23	26	-	-	-	-	-	"omit:""be influenced by"" and add:""exist"" instead of"	Those are risks that can be influenced by geothermal operations, not risks that exist per se.
Abed (National Research Centre)	4	23	26	23	27	-	-	-	"omit:""to the extent that"" and add:""may produce"" instead of"	Repeated. Same comment as 31.
Ferguson (St. Francis Xavier University)	4	23	15	23	19	-	-	-	"The LCA result for direct use is strongly dependent on the source of electricity to run the system. I am not sure if this is what is meant by ""power plant"" and this may warrant some additional discussion. Blum et al. (2009, Renewable Energy 35(10), 122-127) provides some discussion of the effect of regional electricity mixes on CO2 savings in ground source heat pumps. The use of certain refrigerants, such as CFCs, in heat pumps is also a consideration. "	Paragraph is referring to intermediate and low temperature power plants, nor to direct uses.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Williamson (Chevron Corporation)	4	23	15	23	15	4.5.3	-	-	"delete ""micro-"". Seismicity is a hazard, micro-seismicity is not."	New title is "induced seismicity" in Version 1A.
Williamson (Chevron Corporation)	4	23	33	23	33	4.5.3	-	-	Not true - plants have been tripped offline by seismicity in the geothermal field.	There is no mention to geothermal power plants that went off-line by seismicity.
Pehnt (Institute for Energy and Environmental Research)	4	23	-	-	-	-	-	4.5	PO4 must read: PO4 3-	Partially rejected. In SOD it will be used "dissolved phosphate" instead of PO4.
Abed (National Research Centre)	4	24	23	24	35	-	-	-	omit	Paragraph was rephrased in Version 1A. And it is important to mention this economic benefit (CDM).
Gagnon (Hydro-Quebec)	4	24	-	-	-	4.5.4	-	-	"I would suggest to change the title of this section to ""Other benefits and impacts"" since some benefits and impacts have already been discussed in section 4.5.1 to 4.5.3 "	Change made in Version 1A.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	24	22	24	35	4.5.4	-	-	Paragrah seems irrelevant here.	Paragraph was rephrased in Version 1A
Fridleifsson ()	4	24	43		43				Add reference: Fridleifsson et.al., 2008.	Done in Version 1A.
Gagnon (Hydro-Quebec)	4	25	28	-	28	-	-	-	for ease of comparison units (MWe/km2) should be expressed in a similar manner to rest of text and table 4.6 (m2/MWe). Personnaly I would prefer everthing expressed in MWe/km2 giving a better feel for the future power plant dimensions	Data from references are expressed in different units.
Ferguson (St. Francis Xavier University)	4	25	3	25	10	-	-	-	The operation at Basel was shut down for this reason although it could be argued that this was not a commerical development.	That's correct: it was not a commercial plant.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	25	28	-	-	-	-	-	The reference by Sanyal, 2005 is not listed in the references section.	Check-out reference (as a matter of fact, it is necessary to check all of them).
Williamson (Chevron Corporation)	4	25	8	25	8	4.5.5	-	-	Kagel et al (2005) is from the GEA - an industry advocacy group, so not appropriate reference here.	Reference was omitted in Version 1A.
Gagnon (Hydro-Quebec)	4	25	-	-	-	-	-	4.6	(excluding underground reservoirs) would be more descriptive than (excluding wells) in the table	It refers to the land for wells pads, not the complete aquifers.
Gagnon (Hydro-Quebec)	4	25	-	-	-	-	-	4.6	Direct comparison (benchmarking) of land use to other renewables (or non rewables) would be very helpfull here	LCAs of technical chapters agreed not to do comparisons.
Fridleifsson ()	4	25	36		36				Replace "game reserve" with "national park".	Done in Version 1A.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Blankenship (Sandia National Laboratories, New Mexico)	4	27	10	27	34	-	-	-	"The drilling technologies section is odd - discussion of drilling through salt and shale could be an eventual issue but O&G has spent billions on this. Discussion of what they call ""Near Balanced Drilling"" (Managed Pressure Drilling?) is relevant but again a bit odd. Third paragraph is the issue but is only 5 lines long. In general, this section is very weak and given the importance of drilling technologies in geothermal development should receive more attention."	All subsection 6.3 was reviewed and modified.
de Campos (Petrobras)	4	27	11	27	11	-	-	-	Substitution ☐Plastic☐ by ☐Ductile☐. Plastic is not the proper name to the mechanical behavior described. DUCTILE is the correct term in rock mechanics, since brittle behavior is also a plastic one.	Repeated with comment 70.
de Campos (Petrobras)	4	27	14	27	14	-	-	-	Substitution ☐Plastic☐ by ☐Ductile☐. Plastic is not the proper name to the mechanical behavior described. DUCTILE is the correct term in rock mechanics, since brittle behavior is also a plastic one.	Repeated with comment 70.
de Campos (Petrobras)	4	27	15	27	15	-	-	-	Substitution ☐Plastic☐ by ☐Ductile☐. Plastic is not the proper name to the mechanical behavior described. DUCTILE is the correct term in rock mechanics, since brittle behavior is also a plastic one.	Repeated with comment 70.
Williamson (Chevron Corporation)	4	27	34	27	34	4.6.3	-	-	THMC codes are still in the development stage and not yet used by the industry for decision-making.	Paragraph was rephrased in Version 1A.
LEITE DRACHMANN (PETROBRAS)	4	27	14	27	14	4.6.3.1	-	-	Substitution ☐Plastic☐ by ☐Ductile☐. Plastic is not the proper name to the mechanical behavior described. DUCTILE is the correct term in rock mechanics, since brittle behavior is also a plastic one.	Repeated with comment 70.
LEITE DRACHMANN (PETROBRAS)	4	27	15	27	15	4.6.3.1	-	-	Substitution ☐Plastic☐ by ☐Ductile☐. Plastic is not the proper name to the mechanical behavior described. DUCTILE is the correct term in rock mechanics, since brittle behavior is also a plastic one.	Repeated with comment 70.
LEITE DRACHMANN (PETROBRAS)	4	27	11	27	11	4.6.3.1	-	-	Substitution ☐Plastic☐ by ☐Ductile☐. Plastic is not the proper name to the mechanical behavior described. DUCTILE is the correct term in rock mechanics, since brittle behavior is also a plastic one.	Done in Version 1A.
Fridleifsson ()	4	27	38		38				Use a newer reference, Fridleifsson, G.O. et. al., 2010.	Done in Version 1A.
Bilello (NREL)	4	28	40	29	2	-	-	-	Success rates of exploration wells is dependent upon the amount of non-well exploration spending. Improvements in exploration described in 4.6.2 can help increase success rates & decrease well drilling costs - particularly for exploration wells.	Comment noted and accepted, but it is not suggesting any correction.
Williamson (Chevron Corporation)	4	28	4	28	6	4.6.4	-	-	Not appropriate to speculate when new inexpensive designs will appear on the market.	Paragraph was deleted in Version 1A.
Williamson (Chevron Corporation)	4	28	14	28	14	4.7	-	-	"Operational costs are only ""relatively"" predictable - but not predictable because makeup drilling may introduce unexpected costs"	Paragraph was rephrased in Version 1A.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	29	-	47	-	-	-	-	Unused space should reduce used document length by about 2 pages.	To be considered by TSU!
MANNEH (MINISTRY OF FINANCE AND ECONOMIC AFFAIRS)	4	30	27	41	17	-	-	-	The Chapter could be shortened from these ranges or areas without affecting the substance	It is a recommendation to be considered.
Williamson (Chevron Corporation)	4	30	28	30	28	4.7.2	-	-	It is not obvious that a low-temperature case is relevant to EGS. EGS economics will be site-specific, depending strongly on geothermal gradient. Provided EGS can be proven to be viable.	One new paragraph dealing with EGS LCOEs will be added in SOD.
Rosinski (Electric Power Research Institute)	4	31	7	31	7	-	-	-	"Units here. Maintenance is usually listed in $/kW-year not ""$/kWh per year"" As listed $170/kWh per year is $170,000/MWh per year."	That is wrong, since these costs are expressed in 2005 US$: 170 current US$ are equivalent to 152 US$ in 2005.
Gagnon (Hydro-Quebec)	4	31	7	-	-	-	-	-	Not convinced units make economic sense here i.e. 210 US$/kWh per year and 187 US$/kWh per year? Maybe it should be US$/kWe per year ???? Please verify	Units are correct: US$ per kWh produced during one year.
Kutscher (National Renewable Energy Laboaratory)	4	31	7	-	-	-	-	-	The costs here have the wrong units. They should probably be $/kW and not $/kWh.	We are talking about O&M costs, so they refers to kWh, NOT kWe.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	31	5	-	-	-	-	-	Use O&M since this has been defined on line 4 above.	Done in Version 1A.
Williamson (Chevron Corporation)	4	31	21	31	21	4.7.3	-	-	Better wording is that future costs are likely to encompass a wide range	Paragraph on future costs was rephrased in Version 1A.
Abed (National Research Centre)	4	33	20	-	-	-	-	-	"omit:"","" and put:""."" instead of"	Done in Version 1A.
Abed (National Research Centre)	4	33	21	-	-	-	-	-	"omit:""and"" and put:""The results"" instead of"	Done in Version 1A.
Abed (National Research Centre)	4	33	33	-	-	-	-	-	"omit:""which"""	The sense of the phrased would be incomplete.
Fridleifsson ()	4	33	31	34	2				Look carefully at this statement and compare with more recent experience. Much has changed since 1987.	To be changed in SOD
Abed (National Research Centre)	4	35	12	-	-	-	-	-	"If level 4 subheating is added change ""different"" to district "	No level 4 subheading was added.
Williamson (Chevron Corporation)	4	35	7	35	8	4.8	-	-	Binary plants and multi-laterals are not new technology (> 20 years use in geothermal).	Paragraph was rephrased in Version 1A.
Abed (National Research Centre)	4	36	30	-	-	-	-	-	"omit:""%"" and add:""$"""	Done in Version 1A.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Sims (Massey University)	4	36	37	-	47	-	-	-	References needed.	Check references to be added.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	36	27	36	27	-	-	-	The last word is to. Should it be for?	Done in Version 1A.
Fridleifsson ()	4	36	17		17				Remove "technical barriers".	Done in Version 1A.
Fridleifsson ()	4	36	2		2				Replace "high grade hydrothermal" with "hydrothermal".	Done in Version 1A.
Kruger (South African Weather Service)	4	37	1	37	31	4.8	-	-	References to be added to statements and amounts.	Check references to be added.
Williamson (Chevron Corporation)	4	37	17	37	17	4.8.1	-	-	"""saving energy"" should be ""replacing current energy supply"""	Done in Version 1A.
Rybach (Geowatt AG)	4	38	27	-	-	-	-	-	delete 1st sentence in line 27.	Done in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	TOTAL 50.583 155.0 375.0 815.0	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	Region Current (2009) 2020 2030 2050	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	Africa 0.130 2.0 5.0 10.0	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	China 8.898 20.0 50.0 150.0	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	Developing Asia 0.052 1.0 4.0 10.0	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	EJ Equivalent 0.494 1.589 3.843 8.353	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	India 0.265 3.0 6.0 14.0	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	J. Lund (GeoHeatCenter, Klamath Falls/USA, Contributing Author) supplied new numbers for columns 2, 4, 6, 8:	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	Latin America 0.808 3.0 8.0 20.0	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	Middle East 2.362 6.0 10.0 16.0	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	OECD Europe 20.357 60.0 150.0 300.0	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	OECD North America 13.893 50.0 115.0 230.0	Table 4.8 was updated with John Lund figures in Version 1A.
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	OECD Pacific 2.755 7.0 20.0 50.0	Table 4.8 was updated with John Lund figures in Version 1A.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Rybach (Geowatt AG)	4	38	-	-	-	-	-	4.8	Transition Economies 1.063 3.0 7.0 15.0	Table 4.8 was updated with John Lund figures in Version 1A.
Williamson (Chevron Corporation)	4	39	12	45	4	-	-	-	As noted above, only peer-reviewed reference are appropriate	It is not clear what reference is mentioned.
Kruger (South African Weather Service)	4	39	1	39	16	4.8.1.2.	-	-	References to be added to statements and amounts.	To be considered in S.O.D
Kruger (South African Weather Service)	4	39	17	39	27	4.8.1.3	-	-	References to be added to statements and amounts.	To be considered in S.O.D
Abed (National Research Centre)	4	41	7	-	-	-	-	-	"(are plotted"" should be moved to the end of sentence"	Done in Version 1A.
Abed (National Research Centre)	4	41	16	-	-	-	-	-	"omit:""seem to"""	Done in Version 1A.
Abed (National Research Centre)	4	41	14	-	-	-	-	-	"omit:""seems to be"" and add ""is"" instead of"	Done in Version 1A.
GARCIA-GUTIERREZ (INSTITUTO DE INVESTIGACIONES ELECTRICAS)	4	42	1	47	36	-	-	-	Several references are include her but are not cited in the text. These are: Bertani, 2007. Bertani, 2010 Bromley et al., 2006 Hiriart, 2008 I-GET, 2010 Ledru et al., 2007 Lund et al, 2009 Majer et al., 2007 Moeck et al., 2009 Muraoka et al., 2009 US geological Survey (USGS), 2008.	Check references and modify.
Gagnon (Hydro-Quebec)	4	-	-	-	-	-	-	-	"Good chapter, already well reviewed (in Turquoise). A good high level overview of the field a bit skewed towards ""introducing"" EGS. However that I agree that EGS represents a large potential worldwide"	Accepted

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Bilello (NREL)	4	-	-	-	-	-	-	-	"It may be useful to define ""Capacity Factor"" for geothermal plants. EIA reports ""annual generation"" & ""summer capacity"" but does not define to power plants how numbers should be measured or reported. Some plants buy power from the grid for well field pumping, which allows for an seemingly higher overall ""capacity factor' than a plant that uses its own power for well field pumping. Measuring ""capacity"" on a hotter or cooler day will also affect reported ""capacity factor."" Often, papers will cite a 90-95% ""capacity factor"" which really equates to a ""utilization factor,"" Without definition and consistency, ""capacity factor"" numbers and imrpovements may be meaningless. "	It was included a short definition of Capacity Factor in Version 1A of the FOD.
Williamson (Chevron Corporation)	4	-	-	-	-	-	-	-	A paper has been submitted for to the WGC 2010 for publication by the CLA☐ s and LA☐s covering the same topics in this chapter. It contains facts and projections that differ from those in this document	Data have been updated.
contaldi (ISPRA, Institute for Environmental Protection and Research)	4	-	-	-	-	-	-	-	chapter is well done and provides valuable information. I agree with TSU comments and I do not suggest cuts.	Accepted
Rosinski (Electric Power Research Institute)	4	-	-	-	-	-	-	-	Executive summary appears to have been translated into english from another language and is difficult to read. The various sections appear to be written by different authors resulting in stylistic differences in tone and language that should be blended together more effectively to improve flow. Check cross-referencing between text and charts for agreement and consistency.	Accepted
Kleidon (Max-Planck-Institute for Biogeochemistry)	4	-	-	-	-	-	-	-	General comment about chapter 4: I find the beginning of this chapter (sections 4.1 and 4.2) quite confusing. The text seems to mix up estimates for stored amounts of heat in the crust with estimates about how much of this heat can reasonably be extracted over a given time period. The heat storage reservoirs are then stated as energy extraction rates per year -- this clearly reflects a confusion about energy vs. energy rate. It is simply impossible to extract the heat content of 5km crust within one year! Furthermore, this rate is highly non-sustainable, i.e. it can only be extracted once. The current descriptions of resource potential are simply wrong and close attention needs to paid for a careful correction of these estimates!	New table to be included in further versions of Chapter 4.
Kleidon (Max-Planck-Institute for Biogeochemistry)	4	-	-	-	-	-	-	-	General comment: I noticed that in comparison to the other chapters, the references in this chapter are heavily based on conference proceedings and newsletters. It needs to be clarified to what extent this is peer-reviewed literature.	All references will be checked.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Williamson (Chevron Corporation)	4	-	-	-	-	-	-	-	Geothermal Heat Pumps are distinct from geothermal resources in nature and implementation, should be assigned a separate section in the chapter, and not be included projections of geothermal resource size and future growth	GHP are considered in this chapter as a specific geothermal direct use, and the current treatment is correct. However, John Lund (JL) and L. Rybach will be asked about this.
Sugiyama (CRIEPI)	4	-	-	-	-	-	-	-	geothermal heatpumps may be better addressed in ch8 among other (air- and water- thermal) heatpumps as an example of system integration of heatpumps and geothermal technology.	It was agreed by the technical chapters CLAs that GHP be included in Chapter 4.
Williamson (Chevron Corporation)	4	-	-	-	-	-	-	-	Many references in the document are from sources that have not been peer-reviewed to standards acceptable to the scientific community	Chapter 4 will review all the references.
de Haan (Ernst Basler + Partner AG)	4	-	-	-	-	-	-	-	No comments from this expert to chapter 4 geothermal	Accepted
Sugiyama (CRIEPI)	4	-	-	-	-	-	-	-	Political and institutional barriers are more important than costs and technologies in Japan. Key geothermal resources in Japan are in spa and natural park area and they are not available for power generation. See Ehara Sachio et al (2008): Contribution of Geothermal Energy to 2050 Natural Energy Vision in Japan, J. Geotherm. Res.Soc. Japan Vol 30, No.3 (2008) pp 165-179.	It will be included some comment on this issue in the SOD.
SCOWCROFT (EURELECTRIC)	4	-	-	-	-	-	-	-	The IPCC SRREN FOD details the main issues related to the global geothermal heat/cool and power production. Even if EGS systems have a very high potential, in the report the state of the art technologies should be given a higher priority. The text should be crossed-checked for a consistent use of units (EJ, GW, TWh).	Potential of EGS was re-phrased in Version 1A, and units equivalence were carefully cross-checked.
Williamson (Chevron Corporation)	4	-	-	-	-	-	-	-	The SRREN should not be an advocacy document telling policymakers how to make policies. This does not align with the mandate of IPCC assessments and could end up being rejected by policymakers	Chapter 4 team will address this issue, reviewing and rephrasing some parts to avoid that impression.
Budd (Geoscience Australia)	4	-	-	-	-	4.1	-	-	Suggest the Ground heat Pumps have their own classification type. The reason being that heat flows into and out of 'reservoir'. Also makes the point they a geothermal resource (i.e. anomalous heat source) is not needed.	Ask to JL and LR.
SCOWCROFT (EURELECTRIC)	4	-	-	-	-	4.1	-	-	The chapter 4.2 shows the resource potential and refers to the different technologies used for the utilisation of geothermal energy. Therefore, the introduction should contain a short explanation of the different technologies - maybe with figures especially to show the difference between hydrothermal and EGS.	Repeated with No. 47
Vahrenholt (RWE Innogy GmbH)	4	-	-	-	-	4.1	-	-	The chapter 4.2 shows the resource potential and refers to the different technologies used for the utilisation of geothermal energy. Therefore, the introduction should contain a short explanation of the different technologies - maybe with figures especially to show the difference between hydrothermal and EGS.	A paragraph will be added in 4.1. Introduction.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Williamson (Chevron Corporation)	4	-	-	-	-	4.2.1	-	-	There are too many resource estimates in this section that use different assumptions in the calculation. Also, some are from sources that are not peer-reviewed.	We're going to revise the text for clarity.
Budd (Geoscience Australia)	4	-	-	-	-	4.3.1	-	-	Make Ground Heat Pumps an additional resource type, with no relation to magmatic activity necessary.	Ask to JL and LR.
Bilello (NREL)	4	-	-	-	-	4.3.1	-	-	This section is a great summary, but it seems like it should be at the beginning of the chapter. By this point, the reader needs to have understood this for the discussion.	This section is about utilisation and it requires a categorisation according the resource temperature and end use, Earlier in section 4.1 we described the nature of stored geothermal energy.
Williamson (Chevron Corporation)	4	-	-	-	-	4.3.2	-	-	This section needs to be rewritten to adequately describe current exploration methods.	Section has been revised to include current geophysical and other exploration methods.
SCOWCROFT (EURELECTRIC)	4	-	-	-	-	4.3.5	-	-	The mentioned priorities for geothermal research with a focus on EGS are not restricted to EGS - they are important for hydrothermal resources as well.	Title in table was changed in Version 1A.
Vahrenholt (RWE Innogy GmbH)	4	-	-	-	-	4.3.5	-	-	The mentioned priorities for geothermal research with a focus on EGS are not restricted to EGS - they are important for hydrothermal resources as well.	Repeated with comment 49.
Rybach (Geowatt AG)	4	-	-	-	-	4.3.6	-	-	Chapter 4, section 4.3.6 □Technology of submarine geothermal generation□.	Done in Version 1A.
Budd (Geoscience Australia)	4	-	-	-	-	4.3.7	-	-	Add distillation water purification/desalination	Done in Version 1A.
Williamson (Chevron Corporation)	4	-	-	-	-	4.3.7	-	-	I suggest a separate section on GHP to avoid confusion.	Ask to JL and LR.
Budd (Geoscience Australia)	4	-	-	-	-	4.3.7	-	-	Remove reference to geothermal heat pumps - has own section following	Here GHP are only mentioned as one direct use of geothermics.
Budd (Geoscience Australia)	4	-	-	-	-	4.3.8	-	-	Include information on using GHP for domestic hot water in addition to building heating and cooling	May be John Lund can add that information.
Budd (Geoscience Australia)	4	-	-	-	-	4.4.3	-	-	Separate GHP from geothermal resources - insert new section	We'll add a new subsection 4.4.4. Status of GHP and we'll seek for additional advice from JL and LR.
Rosinski (Electric Power Research Institute)	4	-	-	-	-	4.4.4	-	-	agree with TSU comments	Comment noted.
Williamson (Chevron Corporation)	4	-	-	-	-	4.4.4	-	-	This section should describe relevant policies, and their impact on geothermal. There is an advocacy bias in this section which is inappropriate.	Subsection will be rephrased by Chris.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Rybach (Geowatt AG)	4	-	-	-	-	4.5	-	-	"Section 4.5 treats socio-economic implications only marginally. The involvement of local stakeholders as well as social acceptance is indispensable. Therefore the following text (or equivalent wording) should be added at the end of Section 4.5: ☐4.5.6 Socio-economic implications (as new subheading) The realization of geothermal development projects depends on the acceptance by the local residents. Prevention or minimization of detrimental impacts on environment and people as well as the creation of benefits for local communities is indispensable to obtain social acceptance. Therefore the social acceptance of geothermal development in a given area must be considered in all project phases with high priority. People in general, and those living in areas with high-temperature resources in particular, know well the risks and benefits of geothermal projects. With passing time, residents in those areas will become increasingly aware also of their rights to protect their environment and to participate in the management of resources in their territory, as stated by Principle 22 of the Earth Charter. As a consequence, gaining social acceptance from local populations is a condition sine-qua-non of geothermal development. Several examples show that local opposition can hinder or even stop geothermal project realization: Milos and Nysiros (Greece), Mte. Amiata and Latera (Italy), Ohaaki (New Zealand), Mt. Apo (The Philippines), Puna (USA). The necessary prerequisites to secure agreement of local people are: i) Prevention of adverse effects on people☐s health, ii) Minimizations of environmental impacts; iii) Creation of direct benefits for the resident communities.☐"	Idea was accepted but it will be rephrased by Chris Bromley
El-Hinnawi (National Research Centre)	4	-	-	-	-	4.5	-	-	should be re-written and expanded. The environmental impacts of geothermal energy should include: impacts on land- noise- airborne effluents (not only carbon dioxide by hydrogen sulphide ammonia,etc.)- liquid effluents- thermal discharges. See, for example, El-Hinnawi, E. and A. Biswas (1981) : Renewable Sources of Energy and the Environment. Tycooly International, Dublin.	Idea was accepted but it will be rephrased by Chris Bromley
Palvolgyi (Budapest University of Technology and Economics)	4	-	-	-	-	4.5.	-	-	There are no appropriate assessment on the geothermal's impact on environment. Direct effects on the quality of surface and ground water reservoirs, as well as impacts on geothermal resouces should be assessed.	We'll address the issue with more references.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Pehnt (Institute for Energy and Environmental Research)	4	-	-	-	-	4.5.2	-	-	"The CO2-equivalent emission data from section 4.5.2 are based on net electricity production figures. Therefore, the high electricity use by the pumps of the geothermal installation is not visible. If the gross balance is taken, the emissions due to the electricity demand would appear, which will result in significantly higher specific CO2 emissions; on the other hand, each geothermal power plant would then produce more absolute kWh. This is an artefact of the LCA that should be carefully considered --> include a sentence on this issue."	E. Huenges will review the comment and respond.
Budd (Geoscience Australia)	4	-	-	-	-	4.5.4	-	-	Not clear what benefits and impacts should be in here - social, economic, environmental? Clarification of purpose would probably result in better content.	Idea was accepted but it will be rephrased by Chris Bromley
Budd (Geoscience Australia)	4	-	-	-	-	4.5.5	-	-	Other competing uses for land or resource not considered include (1) pore space (eg CO2 sequestration), (2) mining and (3) petroleum	It is not clear what the comment is referring to.
Ferguson (St. Francis Xavier University)	4	-	-	-	-	4.5.5	-	-	This section seems to focus on high temperature developments. There is a growing potential for problems with low temperature developments in this context. There have been documented cases of interference between systems (e.g. Ferguson and Woodbury, 2006, Hydrogeology Journal 14: 1206-1215). There are also some general problems with the scientific basis of current regulations with respect to property rights and environmental impacts (Ferguson, 2009, Ground Water, 47: 167). It is not clear that what development density can be supported by this technology at this point, especially without regional planning.	Section will be reviewed in SOD.
Ferguson (St. Francis Xavier University)	4	-	-	-	-	4.51	-	-	The concept of combining CO2 sequestration with geothermal energy extraction is probably worth mentioning here (Pruess. 2006. Geothermics 35(4): 351-367) .	A short sentence will be added.
Budd (Geoscience Australia)	4	-	-	-	-	4.6.1	-	-	Important to also note the technology exists to utilise all types of geothermal resource now, and depending on government/market all can be commercial.	Comment noted. This idea is stated in further paragraphs.
SCOWCROFT (EURELECTRIC)	4	-	-	-	-	4.7.5	-	-	The costs for geothermal power plants in Germany are mainly driven by drilling costs. Comparing different projects without mentioning the boundary conditions is like comparing apples with oranges.	The cost of geothermal power plants over the world are highly influenced by drilling costs, and that is one of the issues that makes it possible to compare them.
Vahrenholt (RWE Innogy GmbH)	4	-	-	-	-	4.7.5	-	-	The costs for geothermal power plants in Germany are mainly driven by drilling costs. Comparing different projects without mentioning the boundary conditions is like comparing apples with oranges.	Repeated.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
Philibert (International Energy Agecy)	4	-	-	-	-	4.8	-	-	"Given the definition of geothermal energy given in this chapter, so-called ""geothermal heat pumps"" have not much to do with geothermal energy as the bulk of the energy they use as heat source is in fact solar energy trapped in the shallow layer of the Earth. (One may wonder, however, how a limit can be drawn between ""real"" geothermal energy, and solar energy used after its storage in the ground. One simple rule that seem to work in most cases is to consider that if one needs to use a heat pump, that is, the temperature level of the heat transfer fluid has to be raised above that of the warm source, well, this is mostly solar energy, which keeps the soil close to 15□K, usually too low for our purposes. If you have only heat exchangers, that is, the temperature level of the source is higher than that of your transfer fluid, then you're using real geothermal energy. As a result, actual ""geothermal heat pumps"" are very rare). At a minimum, this section should be retitled ""ground-source heat pumps"". Moivng the entire section to the chapter 3 (direct solar) should be considered. The same commenty applies to the title of 4.7.5"	It was agreed by all the LCAs of the technological chapters that GHP be included in Chapter 4. See also Rybach comment No. 105 for Chapter 9, Annex I, lines 36-41.
Pehnt (Institute for Energy and Environmental Research)	4	-	-	-	-	-	4.6	-	"Installed capacity Germany 2009 = 10.87 MWe instead of 7 MWe (Neustadt-Glewe: 0.210 MWe; Landau: 3 MWe; Unterhaching: 3.36 MWe; Gro□Sch□nebeck: >0.750 MWe; Riedstadt: 3 MWe; Bruchsal: 0.550 MWe)"	Figure for Germany is for 2009. Other plants were commissioned in 2010. 7 MW is correct.
Rybach (Geowatt AG)	4	-	-	-	-	-	4.6	-	the range of values plotted (colors deep blue □ deep red, presumably in mW/m2) and the resulting color picture is rather strange: average oceanic heat flow is around 100 mW/m2 whereas average continental heat flow is around 70 mW/m2. Well-known geothermal anomalies like the East African Graben system do not show up.	It is not heat flow but thermal gradient in °C/km. Units corrected in Version 1A.
Takeuchi (Advanced Industrial Science and Technology)	4	-	-	-	-	4.6	5.28-5.32	-	Chapter4.6 is written without reference. It should be written from the stand point of neutral, otherwise this part will be shortened, widely.	There are some references. Recommendation for shortening will be taken into account.
Budd (Geoscience Australia)	4	-	-	-	-	-	-	4.1	Delete Shallow Subtype, insert GHP as a Type	Shallow can be used not only for GHP: they are a subtype per se.
SCOWCROFT (EURELECTRIC)	4	-	-	-	-	-	-	4.1	It does not become not clear enough that GHP can be used in combination with closed loop systems and open well systems.	Repeated: the same as 48.
Vahrenholt (RWE Innogy GmbH)	4	-	-	-	-	-	-	4.1	It does not become not clear enough that GHP can be used in combination with closed loop systems and open well systems.	May be it is not clear in the table, but it is clearly indicated in the text.
Budd (Geoscience Australia)	4	-	-	-	-	-	-	4.1	Replace Hydrothermal in Type with Convective - see line 15	Done in Version 1A.
Williamson (Chevron Corporation)	4	-	-	-	-	-	-	4.2	The separation of resource estimates into Electric and Direct requires explanation.	We'll add a line explaining the caption.
Williamson (Chevron Corporation)	4	-	-	-	-	-	-	4.2	Without market considerations all 'electric' resources could be used for direct heat, and a fraction of 'direct' resources could be used for electricity generation. Table should indicate where there is overlap .	We'll add a line explaining the caption.

Name (Institute)	Chapter	From page	From line	To page	To line	Section	Figure	Table Info	Comments	Considerations by writing team
de Campos (Petrobras)	4	-	-	-	-	-	-	4.3	This is not a table, as there isn't any relationship between the rows, there is just one row	Chapter 4 authors do not share the opinion of this reviewer.
Williamson (Chevron Corporation)	4	-	-	-	-	-	-	4.4	Table 6 in reference Fridleifsson et al., 2008 has 46 GWe in 2030 and 140 GWe in 2050. 25 Gwe by 2020 requires a growth rate of 8.5%, which needs to be justified.	Reference to Fridleifsson was removed.
Pehnt (Institute for Energy and Environmental Research)	4	-	-	-	-	-	-	4.5	Column 3, row 3: the CO2-equivalent range must be 23-63 g/kWh as stated in section 4.5.2 line 38.	It was modified the text, not the table, in Version 1A.
SCOWCROFT (EURELECTRIC)	4	-	-	-	-	-	-	4.7	Case 7: Drilling costs are too low, power plant costs are too high. Total is correct.	Case 7 will be removed in SOD.
Vahrenholt (RWE Innogy GmbH)	4	-	-	-	-	-	-	4.7	Case 7: Drilling costs are too low, power plant costs are too high. Total is correct.	Case 7 will be removed in SOD.
Williamson (Chevron Corporation)	4	-	-	-	-	-	-	4.8	Reference missing	Table 4.8 will be modified in SOD.
Williamson (Chevron Corporation)	4	-	-	-	-	-	-	4.8	There are errors on this graph. It is not from a reliable source.	It refers to FIG. 4.8 (not TABLE 4.8), which was removed in Version 1A.