Economic Commission for Europe

Expert Group on Resource Classification

Application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 to Renewable Energy Resources

Basis for establishing specifications for the application of UNFC-2009 to geothermal energy resources

Report prepared by the Geothermal Working Group

I. Introduction

1. The draft Specifications for the Application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) to Geothermal Energy Resources *as at 18 April 2016 (*ECE/ENERGY/GE.3/2016/6) were presented to the Expert Group on Resource Classification at its seventh session in April 2016.

2. The Expert Group requested that the draft Specifications for the Application of UNFC-2009 to Geothermal Energy Resources be issued for public comment. Following the public comment, the document approval procedure agreed at the fifth session of the Expert Group should be followed (ECE/ENERGY/GE.3/2014/2, paragraph 97). The approval procedure is provided below for ease of reference:

"*(a) Document approval procedure*

The Expert Group recommended in the future that document approvals should conform to the following procedure:

(i) Preparation of a draft document by "working group". During preparation, the Technical Advisory Group should be involved in periodic review/consultation;

(ii) The draft should be subject to a public comment period. Comments should be considered for possible inclusion and the draft modified as appropriate. Reasons for not acting on specific comments should be documented;

(iii) The final draft should be presented to the Expert Group at its annual session. The Expert Group should request that the draft be submitted to the Technical Advisory Group for an appropriate level of review and for recommendation to the Bureau;

(iv) Once agreed by the Bureau, any significant changes from the final draft will be sent to the Expert Group for agreement;

(v) The agreed draft will be sent to the Committee on Sustainable Energy for endorsement."

II. The process

3. In line with the aforementioned approval procedure, the draft generic Specifications for the Application of UNFC-2009 to Geothermal Energy Resources were issued for public comment on the United Nations Economic Commission for Europe (ECE) website for a period of three months. The three-month period ran from 6 June 2016 until 4 August 2016.

4. During the public comment period, eleven responses were received from both individual experts and organizations. All comments were carefully reviewed by the Geothermal Working Group and incorporated as appropriate in the final draft of the specifications document. The public comments and the Working Group's response are detailed in Annex II.

5. The members of the Working Group are listed in Annex I.

6. This report summarizes all the comments received during the public comment period and how the comments were dealt with and considered by the Working Group.

7. Two changes were made to the specifications: (i) removal of the twelve application examples into a separate document; and (ii) deletion of the paragraphs in Section L: *Evaluator Qualifications* relating to Competent Person qualifications.

8. The Technical Advisory Group has been fully involved during the preparation of the final draft text of the Specifications. The Technical Advisory Group supported the view that the feedback received during the Public Comment period did not result in any "significant changes" that would require the Expert Group on Resource Classification to review the document again. The Technical Advisory Group submitted its recommendation to the Bureau of the Expert Group on 9 September 2016. The Bureau reviewed the final draft of the specifications and approved that it be submitted to the Committee on Sustainable Energy at its twenty-fifth session (28–30 September 2016) for endorsement.

III. Recommendations

9. The twelve application examples from Australia, Germany, Hungary, Italy, the Netherlands, New Zealand, the Philippines and Russia, previously included with the Specifications should be issued as a separate document. These examples facilitate understanding of the applicability of UNFC-2009 to Geothermal Energy Resources.

10. The proposed revised draft specifications for application of UNFC-2009 to geothermal energy resources should be submitted to the Committee on Sustainable Energy at its twenty-fifth session (28–30 September 2016) for endorsement.

Annex I

Geothermal Working Group members

The members of the Geothermal Working Group are:

Ms. Gioia Falcone (Cranfield University/IGA)

Mr. Miklos Antics (GPC IP/Geofluid)

Mr. Roy Baria (Mil-Tech UK Ltd)

Mr. Larry Bayrante (Energy Development Corporation)

Mr. Paolo Conti (University of Pisa)

Mr. Malcolm Grant (MAGAK)

Mr. Robert Hogarth (Hogarth Energy Resources),

Mr. Egill Juliusson (Landvirkjun)

Mr. Harmen Mijnlieff (TNO)

Ms. Annamaria Nador (Geological & Geophysical Institute, Hungary)

Mr. Greg Ussher (Jacobs), and

Ms. Kate Young (United States National Renewable Energy Laboratory (NREL))

Observers:

Mr. Graeme Beardsmore, Chair, IGA Reserves and Resources Committee

Mr. Horst Rüter, Director, IGA Service Company

Annex II

Responses to the public comments received between 6 June 2016 and 4 August 2016

Comment from	*Item*	*Comment*	*Geothermal Working Group Response*
Expert Group on Resource Classification (EGRC) Solar Working Group		The Solar Working Group wants to congratulate the Geothermal Working Group for the great work it has done and for leading the way when it comes to preparing specifications for specific types of renewable energy. The Solar Working Group reviewed the Geothermal Specifications: in solidarity with a fellow Group under the Task Force; to better understand what is to be included in such specifications; and, to help ensure there is consistency in the application and description of the EFG axes, as well as presentation of case studies. While reviewing the Geothermal Specifications several ideas, observations and questions occurred to the Group, hence we have drafted the text below as feedback. We found the document to be well constructed, clearly setting out how to classify geothermal resource estimates. In particular, we found the case studies to be very useful and nicely illustrated how the guidelines could be applied to actual projects.	Thank you.
	1.2	The introduction noted that the Geothermal Specifications were to be used in conjunction with the Renewables Specifications and the UNFC-2009. However, the Geothermal Specifications seem adequate for use as a standalone document. How do you envisage people classifying geothermal energy using the Geothermal Specifications in conjunction with the Renewables Specifications and UNFC-2009?	The Geothermal Specifications have not been written as a stand-alone document; the UNFC-2009 incorporating Specifications for its Application and the Renewables Specifications include fundamental, overarching 'rules of application' that are not repeated in the Geothermal Specifications. Users of the Geothermal Specifications are, first and foremost, users of UNFC-2009. Thus, it is strongly recommended that users first familiarise themselves with UNFC-2009 incorporating Specifications for its Application, then with the Renewable Specifications and finally with the Geothermal Specifications. As indicated in the introduction, "5. Text that has been kept

Comment from	*Item*	*Comment*	*Geothermal Working Group Response*
			unaltered from UNFC-2009 incorporating Specifications for its Application and/or the Renewables Specifications is indicated in this document in *italics* for clarity."
	1.3	There is a question as to whether direct use of geothermal heat was counted. For example, in New Zealand some geothermal energy is used directly to heat treat wood. In the Netherlands some low heat geothermal energy is used to keep greenhouses warm. The direct use of heat may be important in solar as well, as it can substitute other forms of energy used for heating.	As stated in section I.A.7 of the Geothermal Specifications, "Examples of Geothermal Energy Products are electricity and heat." Thus, direct use of geothermal heat is not excluded. Two of the application examples explicitly address direct use (Habanero, Hódmezővásárhely), while two others address combined use of electricity and heat (Insheim, Pauzhetsky).
	1.3	The definitions and concepts provided were very useful and are very helpful for the Solar Working Group and its work on Solar Specifications.	Thank you.
	1.4	Whilst the E and F axis have some explanation that can guide the user, it was felt that the G axis has limited description for the geothermal energy. As in oil and gas, there is some uncertainty in the geothermal resource quantification however clear guidelines (such as PRMS from the SPE) and acceptable approaches are available in oil and gas so that the quantification and classification of resources is not user dependent and subjectivity is taken out of the process.	The Working Group would like to point at the extensive description of the G-axis under sections III 21, 22, 23, 24 and IV I of the draft Renewable Specifications (available at http://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrc/egrc7_apr2016/ECE.ENERGY.GE.3.2016.5_e.pdf), stressing that the Geothermal Specifications are not to be read as a stand-alone document. Quantification of Geothermal Energy Resources is a subjective process, as it is for petroleum and minerals. This is due to the fact that the majority of the parameters that define the resources' quantities cannot be measured

Comment from	*Item*	*Comment*	*Geothermal Working Group Response*
			directly and must therefore be estimated indirectly through interpretative modelling. There is no guarantee that two different estimators will return the same estimate. The intent of the Geothermal Specifications is to guide users through the classification process using the quantities they have determined using the data and methods available to them. Consequently, the application examples focus on the classification of the estimated quantities, rather than on their quantification, to complement UNFC-2009 as a classification framework. The EGRC acknowledges that the 'next level of detail' to support the estimation of Geothermal Energy Resources' quantities for classification under the UNFC-2009 would benefit the geothermal community.
	1.5	There is a question as to whether geological guidelines are widely used in the geothermal industry. There are classifications available in Australia* and the United States**. However, it might be useful to have additional information within this document on how to apply the G axis, allowing users to make good use of this classification process. It might also be useful for bridging documents to be prepared, showing how the Australian* and United States standards** correlate to the UNFC and the Geothermal Specifications.	Prior to embarking on the development of the Geothermal Specifications, the EGRC carefully reviewed existing geothermal guidelines, protocols, codes and schemes for possible bridging to the UNFC-2009. The results of the review can be found in Falcone, G., Alimonti, C., Gnoni, A., Harrison, B. (2013), Classification and Reporting Requirements for Geothermal Resources, European Geothermal Congress 2013, Pisa, Italy, 3-7 June 2013 and Falcone, G., Beardsmore, G. (2015), Including Geothermal Energy within a Consistent Framework Classification for Renewable and Non-Renewable Energy Resources, World Geothermal Congress 2015, Melbourne, Australia, 19-25 April 2015.

Comment from	*Item*	*Comment*	*Geothermal Working Group Response*
			After discussions on the review's findings at its sixth session, the EGRC "[…] requested the Task Force to prepare draft commodity specifications for geothermal for review at the seventh session" (http://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrc/egrc6_apr2015/EGRC.6.2015.INF.1_e.pdf) The discussions at the sixth EGRC session mainly focused on the Australian Geothermal Code, which was regarded as a developed document, though of limited geographical acceptance. However, concerns were raised regarding alignment (which is a necessary precursor to a bridging document for the UNFC-2009). It was noted that a solid minerals system (i.e. JORC, on which the Australian Geothermal Code was based) would not be the best starting point for the classification of fluid resources such as geothermal energy resources. In fact, it was known to the EGRC that soon after its initial release, the need to address recovery uncertainty was recognised and a significant change to the Australian Geothermal Code was required, thus deviating from JORC. The current definition for a probable reserve in the Australian Geothermal Code includes the following guidance: "It is more likely than not that the Geothermal Reserve estimate is correct, reflecting a greater than 50% chance of occurrence". However, no reserve estimate is ever "correct". Further, if dealing with a continuous distribution of uncertainty (as it should be the case with the production of fluids), the probability of any one specific outcome (reserve

Comment from	*Item*	*Comment*	*Geothermal Working Group Response*
			estimate) is zero. The EGRC felt that this current definition/guidance was a direct consequence of trying to apply a solids-based system (i.e. JORC) to fluids and the fundamental difference in the way uncertainty/confidence is handled. Looking at the current PRMS definition, it is in respect of proved plus probable reserves (reflecting the continuous nature of the uncertainty) and states: there should be "at least a 50% probability that the actual quantities recovered will equal or exceed the 2P [Proved plus Probable] estimate". Currently, there does not appear to alignment with either JORC (moderate confidence) or PRMS (2P at least P50). Other issues in relation to the Australian Geothermal Code were also raised in Grant, M.A. (2015), Resource Assessment, a Review, with Reference to the Australian Code, World Geothermal Congress, Melbourne, Australia, 19-25 April 2015.
	1.6	The case studies definitely will help users to understand how to classify the resources in G1, G2, and G3 however not all of the examples are as detailed as others. Additional information for some of the case studies could be beneficial.	Unfortunately, without specific reference to the application examples that are felt to be less detailed, or to the additional information that could be beneficial, The Working Group cannot effectively address this comment.
	1.7	On the question of applying the Geothermal Specifications, it might be possible to apply the Specifications to the US geothermal resource assessments from 1975^, 1978^^ and 2008^^^. While these are not projects specific assessments, they are of public policy interest and would demonstrate the applicability of the Geothermal Specifications to official statistics and resource assessments coming out of government. Furthermore, it would demonstrate the applicability of UNFC within	Thank you for this suggestion. Please note that several stakeholders have offered to have their Geothermal Energy Resources classified under the UNFC-2009, both at national level and at project level. Some of the application examples presented in Annex II of the current Geothermal Specifications already deal with regional classifications

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		the System of Environmental Economic Accounting (SEEA), which includes national physical stocks.	as opposed to project specific, e.g. the Dutch Rotliegend Play Area, the Aggregation GSHP-Potential, North Rhine Westphalia, Germany. Although the Working Group will certainly consider the US case for possible inclusion among the application examples, assuming availability of all necessary information in the public domain, it is hoped that the geothermal community will start making independent use the Geothermal Specifications as soon as they are operational. The EGRC is already looking at harmonising the interface between UNFC-2009 and the SEEA system. This activity, however, falls outside the specific mandate of this Working Group.
	1.8	Thank you again for the opportunity to review the Geothermal Specification. The Solar Working Group will be grateful for any response to the feedback above.	Thank you. We have addressed your feedback and we trust you will find our responses satisfactory.
Duncan Foley	2.1	Thank you for the opportunity to comment on the Draft Specifications for Application of UNFC-2009 to Geothermal Energy Resources. I have two general comments and several comments that may help to strengthen the examples.	Thank you for your input.
	2.2	I suggest that two tables be added to the standards. One should be a flow unit conversion table, and the second an energy unit conversion table. Such tables would help an international audience put key data into familiar terms. Not all readers will be familiar with all units for flow or energy, so presenting conversions could help.	Under section I. M of the Geothermal Specifications it is stated that “60. Estimated quantities shall be reported in Joule (J) or multiples of the Joule. However, it is recognized that there are traditional measurement units that are widely used and accepted in the geothermal energy sector; such units can therefore be added in parenthesis next to the Joule value. 61. Where applicable, conversion factors (e.g., if quantities are converted from thermal energy to electricity) shall be disclosed.”

Comment from	*Item*	*Comment*	*Geothermal Working Group Response*
			Please note that the application examples adhere to this logic.
	2.3	For existing and any new graphics, I suggest that a red-green color scheme may not be helpful for colorblind readers. There are websites that can be used to test various graphics for colorblind visual compatibility.	Noted, thank you. The Working Group has passed this suggestion onto UNECE's Sustainable Energy Division for consideration.
	2.4	The criteria state that the people doing the evaluations should be identified. The evaluators are not identified in the examples. I think they should be.	The application examples are a result of the team effort of this Working Group. All the members of the Working Group are named in the Acknowledgements section of the Geothermal Specifications.
	2.5	If case studies are going to be broadly applicable and followed, I suggest that the citation of references be greatly strengthened. References to published, gray, or in-house publications should be included for all key data and interpretations.	All relevant references from which the information presented in the application examples was taken are cited and included. Unfortunately, this comment does not point at any specific data or interpretations that may have not been reference properly; hence, the Working Group is unable to address this point further.
	2.6	While I like the idea of listing at the beginning of case studies the data date and the evaluation date, I note that in some cases the references cited don't support the dates. For example, the Alto Peak case study lists a data date of December 2014 and an evaluation date of September 2015. The most recent reference, however, is 1997, which is 18 years before the evaluation. If nothing was written on this area in those 18 years, it should be clearly noted in the evaluation.	In the application examples, the Date of Evaluation is the date when the examples were prepared by the Working Group; the Data Date is the date of the data as made available in the public domain. The Working Group agrees with the comment on Alto Peak, the reference cited and the gap of 18 years. The operating company

Comment from	*Item*	*Comment*	*Geothermal Working Group Response*
			carried out further studies/activities during the gap period, specifically on the acid resource. However, the internal company reports cannot be cited, due to proprietary nature of the activities, following the privatization of EDC in 2007. Text will be added to the Alto Peak application example to clarify this.
	2.7	There are places in the case study examples where phrases like "present technology" are used. The examples need to be clear about when the date of the so-called "present" is. In this case (Alto Peak) the term seems to refer to 1997, not 2015. A few things might have changed in those 18 years. The phrase "so far" (pg. 57) seems to refer to 2010 rather than the 2016 date of the evaluation. Which date is it really? Instructing evaluators to use exact dates rather than qualitative terms would be helpful.	Following comment 2.6 above, text will be added to the Alto Peak application example to clarify this.
	2.8	In many of the examples I had to dig for key data. How about requiring a table at the beginning that lists key parameters such as production temperature, flow rates, aquifer characteristics, depths of productive zones, etc.? Data in this table should be clearly identified as measured or anticipated. For anticipated data, the table could include a column describing the basis for the estimate. Such estimates then should be clearly supported by the evaluation or sources cited for the evaluation. This would help me, as a reader of an evaluation, have context ahead of my reading the details.	The intent of the Geothermal Specifications is to guide users through the classification process using the quantities they have determined using the data and methods available to them. Consequently, the application examples focus on the classification of the estimated quantities, rather than on their quantification, to complement UNFC-2009 as a classification framework. The EGRC acknowledges that the 'next level of detail' to support the estimation of Geothermal Energy Resources' quantities for classification under the UNFC-2009 would benefit the geothermal community.
	2.9	Where abbreviations are used in examples they should be explained. Readers should not have to guess.	Unfortunately, this comment does not point at any specific abbreviation. The Working Group will review all application examples to try and identify them.

Comment from	*Item*	*Comment*	*Geothermal Working Group Response*
	2.10	Where formulas are used in examples, the units should be specified. Readers should not have to guess.	Unfortunately, this comment does not point at any specific formulae. The Working Group will review all application examples to try and identify them.
	2.11	I suggest that where examples use tables such as that on page 34 (Habanero), that both the incremental increases and total energy for each estimate be made clear. At a quick glance, the format of this table makes it look like the low estimate is the most energy, and the best and high estimates are actually relatively small amounts. I understand that the numbers are incremental, but adding the totals to each category would make it faster for the reader to understand what is being said.	The Working Group would like to point at additional guidance on G1, G2, G3 and G1, G1+G2, G1+G2+G3 reporting options under section IV I of the draft Renewable Specifications (available at http://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrc/egrc7_apr2016/ECE.ENERGY.GE.3.2016.5_e.pdf).
	2.12	When terms are used that are important in local descriptions but might not be broadly understood, such as “risorgive” in the case study of Canavese, the terms should be explained in the text or a footnote. This term, for instance, does not show up in the US version of the glossary of geology. It does show up in a Google search, but primarily with references in Italian. Not all readers will speak local languages.	The term “risorgive” will be replaced with “natural springs” in the Canavese application example.
	2.13	When computer programs are used to support examples, they should be specifically named. Saying, as case study 10 does on page 79, “a commercial dynamic building simulator” is not specific enough. Maybe there is only one, but readers may not know this.	Naming commercial packages in the application examples has been deliberately avoided for two main reasons: 1) The intent of the Geothermal Specifications is to guide users through the classification process using the quantities they have determined using the data and methods available to them. Consequently, the application examples focus on the classification of the estimated quantities, rather than on their quantification, to complement UNFC-2009 as a classification framework. 2) Unnecessary commerciality would risk to bias the readers, leading them to believe that the results from program XYZ are to be preferred over the results from other

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			programs. This does not imply that Evaluators shall not be allowed to state the tools used in real-life evaluations.
Roy Mink (comments submitted as own observations and not as an official response from the GRC Technical Standards Committee)	3.1	The title "Specifications for Application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009" is somewhat misleading by not mentioning geothermal. It would be easy to look over the geothermal focus on a search for the document. With a focus on fossil and mineral resources and deposits, the document title does not adequately reflect the unique nature of a geothermal resource.	The Working Group agrees that the current title of the UNFC-2009 is misleading, only referring to fossil energy and mineral resources. This issue has already been discussed by the EGRC and it is likely that, for its next revision in 2018 (TBC), the title of the UNFC-2009 will be reconsidered.
	3.2	In addition, it would be easier to understand the flow of the document if the geothermal section were inclusive and did not rely on components of the other fort (sic) documents dividing (sic) standards for other energy resources.	The Geothermal Specifications have not been written as a stand-alone document; the UNFC-2009 incorporating Specifications for its Application and the Renewables Specifications include fundamental, overarching 'rules of application' that are not repeated in the Geothermal Specifications. Users of the Geothermal Specifications are, first and foremost, users of the UNFC-2009. Thus, it is strongly recommended that users first familiarise themselves with the UNFC-2009 incorporating Specifications for its Application, then with the Renewable Specifications and finally with the Geothermal Specifications. As indicated in the introduction, "5. Text that has been kept unaltered from UNFC-2009 incorporating Specifications for its Application and/or the Renewables Specifications is indicated in this document in *italics* for clarity."

Comment from	*Item*	*Comment*	*Geothermal Working Group Response*
	3.3	The evaluator qualifications seem quite rigid with 5 years of experience in the type of resource and 4 years of formal course work. I would recommend the 5 years of experience or 2 years of experience with 4 years of formal course work in geoscience or engineering would be sufficient. In project evaluation, experience is often more valuable than extensive formal course work.	Currently, the UNFC-2009 states "Evaluators must possess an appropriate level of expertise and relevant experience in the estimation of quantities associated with the type of deposit under evaluation. More detailed specifications can be found in relevant commodity-specific systems that have been aligned with UNFC-2009", noting that, in addition, regulatory bodies may explicitly mandate the use of a "competent person", as defined by regulation, with respect to corporate reporting. Following TAG and EGRC Bureau review, items 55, 56, and 57 have been removed, as it is felt to be premature to include prescriptive Evaluator qualifications within individual bridging or specification documents without further guidance in the UNFC-2009 or in the Renewable Specifications. Further recommendations on Evaluator qualifications and disclosure guidance will remain the responsibility of the EGRC Bureau, advised by the TAG.
	3.4	I recommend the inclusion of megawatts (MW) for energy along with joules (J). Much of industry reports worldwide use megawatts as an energy value while scientific studies use joules. Including a table of conversion would also be helpful. In evaluation of the geothermal resource, joules (J) and megawatts thermal (MWt) would be required. Then evaluating the power output of a project, megawatt hours (MWh) would allow for energy conversion efficiency of a power plant.	Under section I. M of the Geothermal Specifications it is stated that "60. Estimated quantities shall be reported in Joule (J) or multiples of the Joule. However, it is recognized that there are traditional measurement units that are widely used and accepted in the geothermal energy sector; such units can therefore be added in parenthesis next to the Joule value. 61. Where applicable, conversion factors (e.g., if quantities are converted from thermal energy to electricity) shall be disclosed."

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			Please note that the application examples adhere to this logic. As stated in section I.A.8 of the Geothermal Specifications, "Geothermal Energy Resources are the cumulative quantities of Geothermal Energy Products that will be extracted from the Geothermal Energy Source, from the Effective Date of the evaluation forward (till the end of the Project Lifetime/Limit), measured or evaluated at the Reference Point." Thus, the actual Geothermal Energy Resource as defined in the Geothermal Specifications is energy (J), which is not to be confused with power (J/s or W), i.e. the rate of energy use/extraction.
	3.5	In the example, a 'Reference Point' definition would be helpful. This would set the evaluation base line for projects which are not mature. A mature project has an established reference point for the evaluation. The conceptual nature of the term is confusing.	The Working Group would like to point at sections I.C.14-17 of the Geothermal Specifications, and also to the several applications examples presented in Annex II, each with a specified Reference Point.
	3.6	The examples could add more explanation such as naming and describing the models and computer programs used in the evaluation and including references, better explanation of acronyms and abbreviations, establish or reference dates of the technology used to better understand the state of technology between older data and evaluation techniques versus newer data with up-to-date technology. The mixing of old technology/techniques with the new could be misleading without adequate explanation.	Naming commercial packages in the application examples has been deliberately avoided for two main reasons: 3) The intent of the Geothermal Specifications is to guide users through the classification process using the quantities they have determined using the data and methods available to them. Consequently, the application examples focus on the classification of the estimated quantities, rather than on their quantification, to complement UNFC-2009 as a classification framework. 4) Unnecessary commerciality would risk to bias the readers, leading them to believe that the results from program XYZ are to be preferred over

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			the results from other programs. This does not imply that Evaluators shall not be allowed to state the tools used in real-life evaluations. Unfortunately, this comment does not point at any specific abbreviation. The Working Group will review all application examples to identify them. Unfortunately, this comment does not point at any specific application example. If it is Alto Peak, the Working Group will address this as per points 2.6 and 2.7 above.
Sigurd Heiberg, Chairperson, Petronavit a.s	4.1	Thank you for distributing an excellent draft and for the invitation to comment on it. In the attached PDF, you will find annotations that reflect both minor edits and more substantial points. The comments are limited to the text, not the appendices.	Thank you for your input.
	4.2	A general comment is that the 105-page document should be published in parts, not as one book for purely practical reasons. The excellent case studies should be published as separate parts in order to facilitate communication on the essential specifications.	Agreed. The twelve application examples have now been removed from the Geothermal Specifications and should be issued as a separate document. These examples facilitate understanding of the applicability of UNFC-2009 to Geothermal Energy Resources.
	4.3	I invite the Working Group to consider whether the specifications can be made applicable to geothermodynamic energy resources, i.e. heat and pressure as these are not only analogous but also often complementary. In oil and gas, this is known as reservoir energy. The link to UNFC-2009 will thereby also be more obvious.	When applicable, reservoir pressure (and its evolution over time) is embedded in the quantification of Geothermal Energy Resources and is related to the Project definition. As such, it should not require separate handling, unless pressure is used/sold a separate Energy Product. Section I.A.7 of the Geothermal Specifications state “Examples of Geothermal Energy Products are electricity and heat. Other products, such as inorganic

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			materials (e.g. silica, lithium, manganese, zinc, sulphur), gases or water extracted from the Geothermal Energy Source in the same extraction process do not qualify as Geothermal Energy Products. However, where these other products are sold, the revenue streams should be included in any economic evaluation." Considering also the definition in section I.A.6, "In the geothermal energy context, the Renewable Energy Source is the thermal energy contained in a body of rock, sediment and/or soil, including any contained fluids, which is available for extraction and conversion into energy products.", pressure would not qualify as Geothermal Energy Products. However, it would be possible to include the revenue stream (or OPEX reduction, if re-used within) associated to a sale of electricity, if the Project uses the pressure within the Geothermal Energy Source to produce electricity. The Geothermal Specifications alone are not currently designed to handle hybrid energy projects.
	4.4	I recommend a review of the requirements to disclose. David Elliott has made it clear in the Expert Group on Resource Classification that classification and disclosure are not related. The owner of the information, and sometimes the Government, decides what part of the classified information should be disclosed. UNECE does not regulate disclosures. Any disclosure requirements mentioned in the draft should therefore be replaced by requirements to assess, evaluate etc.	Following TAG and EGRC Bureau review, items 55, 56, and 57 have been removed, as it is felt to be premature to include prescriptive Evaluator qualifications within individual bridging or specification documents without further guidance in the UNFC-2009 or in the Renewable Specifications. Further recommendations on Evaluator qualifications and disclosure guidance will remain the responsibility of the EGRC Bureau, advised by the TAG.

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	4.5	Comments from PDF file	The comments on the geothermodynamics have been addressed under point 4.3 above. The comments on Evaluator qualifications have been addressed under point 4.4 above.
Ladislaus Rybach	5.1	I already commented on version 1 February 2016. This version is highly welcome and needed help to fix geothermal resource estimation results of specific projects in the 3D coordinate system (E, F, G axes) of UNFC-2009.	Thank you.
	5.2	It needs to be emphasised that a uniform and generally accepted, reasonable and reliable resource estimation method does not exist so far. Without a standard method the assignment of results of specific cases to the UNFC-2009 E-F-G axes system could remain vague.	The intent of the Geothermal Specifications is to guide users through the classification process using the quantities they have determined using the data and methods available to them. Consequently, the application examples focus on the classification of the estimated quantities, rather than on their quantification, to complement UNFC-2009 as a classification framework. The EGRC acknowledges that the 'next level of detail' to support the estimation of Geothermal Energy Resources' quantities for classification under the UNFC-2009 would benefit the geothermal community.
Manfred P. Hochstein	6.1	There are significant uncertainties in the G-axis part of the specifications, i.e. probability of Known versus Potential Sources, that still require discussion.	Please see responses below.
	6.2	For prospects related to geothermal reservoirs hosted by volcanic rocks, the assessment of the potential of the inferred resource should introduce the geological setting and the natural heat loss of prospects in the G-axis discussion (examples where such discussion would be required are case studies 1,7, 8, and 12).	The intent of the Geothermal Specifications is to guide users through the classification process using the quantities they have determined using the data and methods available to them. Consequently, the application

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	6.3	Most high T prospects in developing countries (S-hemisphere and Africa) appear to be associated with volcanic geothermal resources. In all these cases a discussion of the observed natural heat loss associated with manifestations should be introduced in the G-axis discussion.	examples focus on the classification of the estimated quantities, rather than on their quantification, to complement UNFC-2009 as a classification framework. The EGRC acknowledges that the 'next level of detail' to support the estimation of Geothermal Energy Resources' quantities for classification under the UNFC-2009 would benefit the geothermal community.
	6.4	The potential energy estimates for prospects associated with strato-volcanoes and caldera settings (and other volcanic geothermal prospects) tend to be poor estimates if the volume method is used and the areal extent of the resource is estimated by using resistivity data (mainly MT surveys). Such assessments usually assume that low resistivity structures reflect on-going thermal alterations of host rocks in a present day hot fluid T-field – the possible effect of resistivity structures caused by palaeo-fluids and decaying systems have to be considered (if deep drill hole information is not available).	
	6.5	Despite advances in the theory of MT interpretation, the problem of pseudo-resistivity anomalies caused by terrain effects requires attention and could be mentioned in the G-Axis discussion. The terrain effect in a setting such as case study 1 is small and can be reduced, the effect in steep volcanic terrain, however, (case study 7), can produce topography-controlled pseudo-anomalies.	
	6.6	For prospects with acid feeder structures (such as at Alto Peak) only a G4 type assessment might be justified since there are examples in the literature showing that casing corrosion in such a setting can lead to an early abandonment of exploitation (the old Dieng Field in Indonesia, for example). A (deep) fluid-quality (G-axis) information could be added to volcanic geothermal prospects.	These aspects are best handled by the E and F axes, not by the G axis. When an estimated quantity is classified as G1/2/3 instead of G4.1/2/3, there is no guarantee that it would rank high on the E and F axis. For example, F4 can be used when "No development project or mining operation has been identified." / "In situ (in-place) quantities that will not be produced by any current development project or mining operation." The Alto Peak case study refers to the sector within the project area where the resource is interpreted to be less aggressive (pH <4) and

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			can therefore be addressed using emerging technologies on acid resource utilization (e.g. acid inhibitors, cladding). While earlier models refer to the acid feeder being present in Alto Peak, this is structurally controlled and limited to the chimney of Alto Peak. The hydrothermal model of Alto Peak is described in Reyes et al., 1993. An example of currently operating acid geothermal resource (installed capacity 3 MW) is Hachijojima, Japan. In the Philippines, a 5 MWe Biliran geothermal power plant is due for commissioning in 2016. The project is considered analogue to Alto Peak. The Working Group will add these clarifications to the Alto Peak application example.
	6.7	Concealed outflow structures of volcanic geothermal systems occur and can be mis-identified as a primary reservoir (the Tiwi example) – a G4 type discussion of the regional hydrological setting would be helpful.	Tiwi is not among the application examples included in Annex II. The intent of the Geothermal Specifications is to guide users through the classification process using the quantities they have determined using the data and methods available to them. Consequently, the application examples focus on the classification of the estimated quantities, rather than on their quantification, to complement UNFC-2009 as a classification framework. The EGRC acknowledges that the 'next level of detail' to support the estimation of Geothermal Energy Resources' quantities for classification under the UNFC-2009 would benefit the geothermal community.

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	6.8	One can assume that a proper UNFC edited document will be used to raise equity by the developer of a geothermal resource – whether all such documents could or should be used for raising funding, if the G-axis discussion remains as it is in the draft, is a problem we should think about.	Editing the UNFC-2009 is outside the mandate of The Working Group, who would also like to point at the extensive description of the G-axis under sections III 21, 22, 23, 24 and IV I of the draft Renewable Specifications (available at http://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrc/egrc7_apr2016/ECE.ENERGY.GE.3.2016.5_e.pdf), stressing that the Geothermal Specifications are not to be read as a stand-alone document.
Geosciences and Reservoir Engineering Group (GREG), Energy Development Corporation (EDC), Philippines	7.1	Why is there a need for yet another methodology for geothermal resource assessment?" We have the Australian Code and the Canadian Code. These two codes were formulated as a guide to allow developers to source funds on stock markets with a transparent and reproducible approach to resource assessment which was intended to make it easy to compare one resource with another on exactly the same basis. In spite of the UNECE assertion in the report summary, for there being no globally agreed guideline for resource assessment in 2009, it is worth noting that both the Australian and Canadian codes were in existence at that time and although these may not have gained global acceptance, a lot of resource assessments have been done under these codes in at least Australia, Canada, Chile, Peru, the Azores, Vanuatu, Indonesia and New Zealand. The UNECE should recognize that these de facto standards for resource assessment predate the UNECE code and they should provide a comprehensive review of these older codes with justifications as to why the need to present yet another code and to describe the advantages and improvements that the UN code offers	Prior to embarking on the development of the Geothermal Specifications, the EGRC carefully reviewed existing geothermal guidelines, protocols, codes and schemes for possible bridging to the UNFC-2009. The results of the review can be found in Falcone, G., Alimonti, C., Gnoni, A., Harrison, B. (2013), Classification and Reporting Requirements for Geothermal Resources, European Geothermal Congress 2013, Pisa, Italy, 3-7 June 2013 and Falcone, G., Beardsmore, G. (2015), Including Geothermal Energy within a Consistent Framework Classification for Renewable and Non-Renewable Energy Resources, World Geothermal Congress 2015, Melbourne, Australia, 19-25 April 2015. After discussions on the review's findings at its sixth session, the EGRC "[…] requested the Task Force to prepare draft commodity specifications for geothermal for review at the seventh session" (http://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrc/egrc6_apr2015/EGRC.6.2015.INF.1_e.pdf) The discussions at the sixth EGRC session mainly focused on the

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			Australian Geothermal Code, which was regarded as a developed document, though of limited geographical acceptance. However, concerns were raised regarding alignment (which is a necessary precursor to a bridging document for the UNFC-2009). It was noted that a solid minerals system (i.e. JORC, on which the Australian Geothermal Code was based) would not be the best starting point for the classification of fluid resources such as geothermal energy resources. In fact, it was known to the EGRC that soon after its initial release, the need to address recovery uncertainty was recognised and a significant change to the Australian Geothermal Code was required, thus deviating from JORC. The current definition for a probable reserve in the Australian Geothermal Code includes the following guidance: "It is more likely than not that the Geothermal Reserve estimate is correct, reflecting a greater than 50% chance of occurrence". However, no reserve estimate is ever "correct". Further, if dealing with a continuous distribution of uncertainty (as it should be the case with the production of fluids), the probability of any one specific outcome (reserve estimate) is zero. The EGRC felt that this current definition/guidance was a direct consequence of trying to apply a solids-based system (i.e. JORC) to fluids and the fundamental difference in the way uncertainty/confidence is handled. Looking at the current PRMS definition, it is in respect of proved plus probable reserves (reflecting the continuous nature of the uncertainty) and states:

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			there should be "at least a 50% probability that the actual quantities recovered will equal or exceed the 2P [Proved plus Probable] estimate". Currently, there does not appear to alignment with either JORC (moderate confidence) or PRMS (2P at least P50). Other issues in relation to the Australian Geothermal Code were also raised in Grant, M.A. (2015), Resource Assessment, a Review, with Reference to the Australian Code, World Geothermal Congress, Melbourne, Australia, 19-25 April 2015.
	7.2	Page 9. Introduction. It is noted that two additional reports should be read in conjunction with the report reviewed. It would be much preferable if these were incorporated into a single, stand alone document.	This is not currently envisaged. The Geothermal Specifications have not been written as a stand-alone document; the UNFC-2009 incorporating Specifications for its Application and the Renewables Specifications include fundamental, overarching 'rules of application' that are not repeated in the Geothermal Specifications. Users of the Geothermal Specifications are, first and foremost, users of the UNFC-2009. Thus, it is strongly recommended that users first familiarise themselves with the UNFC-2009 incorporating Specifications for its Application, then with the Renewable Specifications and finally with the Geothermal Specifications.
	7.3	Page 9. Item 6. The thermal energy source should be present in a local accumulation of anomalously high amounts of heat relative to its surroundings. For this reason we question whether ground source heat pumps should be included in the discussion as they rely only on	The Working Group is not aware of a universally established definition requiring that a thermal energy source be present in a local accumulation of anomalously high amounts of heat relative to its surroundings. Application

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		temperatures which are at normal back ground levels in the shallow subsurface.	examples 9, 10 and 11 illustrate how the Geothermal Specifications can be applied to GSHPs projects.
	7.4	Page 9. Item 7. Why only limit the Geothermal Energy Product to electricity and heat. Other byproducts such as those listed should also be considered. If inorganic materials have revenue streams which should be included in any economic evaluation it must logically follow that the inorganic materials do qualify as Geothermal Energy Products.	Section I.A.6 states that "In the geothermal energy context, the Renewable Energy Source is the thermal energy contained in a body of rock, sediment and/or soil, including any contained fluids, which is available for extraction and conversion into energy products." Consequently, as stated in section I.A.7, "Examples of Geothermal Energy Products are electricity and heat. Other products, such as inorganic materials (e.g. silica, lithium, manganese, zinc, sulphur), gases or water extracted from the Geothermal Energy Source in the same extraction process do not qualify as Geothermal Energy Products. However, where these other products are sold, the revenue streams should be included in any economic evaluation." The Geothermal Specifications are not currently designed to handle hybrid energy projects.
	7.5	Page 10/11. Item C. There should be some mention of revenues from the project being inflation indexed to allow for a gradual increase in revenues with time.	Prescribing how to perform a cash flow analysis of a Geothermal Energy Project is not the goal of the Geothermal Specifications.
	7.6	Page 12. This is where the report would benefit greatly from a robust presentation on the axes (as noted above in terms of the two additional reports located elsewhere). In this regard we found "Figure 1: UNFC Categories (ECE 2013)" and associated discussion in Grant and Ussher (2015) to be most helpful.	The Geothermal Specifications have not been written as a stand-alone document; the UNFC-2009 incorporating Specifications for its Application and the Renewables Specifications include fundamental, overarching 'rules of

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			application' that are not repeated in the Geothermal Specifications. Users of the Geothermal Specifications are, first and foremost, users of the UNFC-2009. Thus, it is strongly recommended that users first familiarise themselves with the UNFC-2009 incorporating Specifications for its Application, then with the Renewable Specifications and finally with the Geothermal Specifications.
	7.7	"Page 12 - Foreseeable future". Is "foreseeable future" based on the assumed technological horizon for energy extraction and development? In the Case Study given for the Alto Peak example, "Foreseeable future " is apparently used in a longer term context as it is most unlikely that this field could be adequately delineated and developed within the "foreseeable future" (i.e. in < 5 years) given the issues that the resource presents for an acidic magmatic fluid core ("chimney") which will prove very challenging for materials engineering, both in wells and surface plant.	The Alto Peak case study refers to the sector within the project area where the resource is interpreted to be less aggressive (pH <4) and can therefore be addressed using emerging technologies on acid resource utilization (e.g. acid inhibitors, cladding). While earlier models refer to the acid feeder being present in Alto Peak, this is structurally controlled and limited to the chimney of Alto Peak. The hydrothermal model of Alto Peak is described in Reyes et al., 1993. An example of currently operating acid geothermal resource (installed capacity 3 MW) is Hachijojima, Japan. In the Philippines, a 5 MWe Biliran geothermal power plant is due for commissioning in 2016. The project is considered analogue to Alto Peak. The Working Group will add these clarifications to the Alto Peak application example.
	7.8	The EFG tables in Annex I on pages 17 to 25 are good but as mentioned it would be much better had these been supplemented with a figure and description of the EFG "cube".	The Geothermal Specifications have not been written as a stand-alone document; the UNFC-2009 incorporating Specifications for its Application and the Renewables Specifications include fundamental, overarching 'rules of

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			application' that are not repeated in the Geothermal Specifications. Users of the Geothermal Specifications are, first and foremost, users of the UNFC-2009. Thus, it is strongly recommended that users first familiarise themselves with the UNFC-2009 incorporating Specifications for its Application, then with the Renewable Specifications and finally with the Geothermal Specifications.
	7.9	On the F-Axis categories (Section J, Clauses 36-45; Annex 1), about co-generation of geothermal energy with other energy sources, e.g. biomass waste heat or solar heating of geothermal brine for additional energy (for electricity and/or heat). How do we account for the additional development or generation from such methods, which are basically surface-related but still applied to geothermal?	The Geothermal Specifications alone are not currently designed to handle hybrid energy projects.
	7.10	On G-axis categories (Section K, and Annex 1): How is the classification and uncertainty of geothermal energy resource determined, if the constraint is more social or political in nature and not technical (geologic, etc)? In some cases the parameters used in Monte Carlo runs such as area may be dictated by such constraints. Or is this not considered here?	Socio-political are handled by the E axis, not the G axis. A preliminary report on development of draft guidance on accommodating environmental and social considerations in UNFC-2009 was issued at the 7th EGRC session (see http://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrc/egrc7_apr2016/ECE.ENERGY.GE.3.2016.8_e.pdf and http://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrc/egrc7_apr2016/ECE.ENERGY.GE.3.2016.8.Corr.1_e.pdf).
	7.11	**Habanero (Pages 31 to 34)** The project is adjudged on E axis considerations (E2) to become viable in the foreseeable future (i.e. within 5 years). However on F axis criteria the project is considered to be F2.2 which by definition means commercial development of the project may be subject to a significant delay which we	Please note that the actual definition of F2.2 is "Project activities are on hold and/or where justification as a commercial development may be subject to significant delay."

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		would think will be well in excess of 5 years. This suggests that the E2 rating should better be revised to E3.	
	7.12	Alto Peak In the Case Study review, practically no mention is made of the nature of the magmatic acidic core at Alto Peak but it is recognized that the field is "immature". In spite of this a total of 10 wells were drilled and a feasibility study undertaken after the first 4 of these which assessed the field as being "technically and economically feasible". The 6th and 7th wells proved to be highly acidic and a full evaluation of the impact of this on future development plans is still required. Another issue that this project raises is that a Monte Carlo simulation of a geothermal resource raises no questions on the usability of the produced geothermal fluids. It simply assesses hot fluid available in the rock, irrespective of chemistry. If the fluids are acidic, they cannot be used to transfer the resource heat to surface facilities. The resource has been classified as E2:F2.2, G1+G2+G3. We believe this should instead be E3: F4.2: G1+G2+G3. This point demonstrates that subjectivity of the evaluator can creep in to this process and the impact of the term "foreseeable future". Research work is currently ongoing at producing acid magmatic geothermal systems but it is most unlikely that these studies will be concluded and commercially implemented within the "foreseeable future", i.e. within 5 years.	The Alto Peak project underwent several resource assessments and feasibility reviews. Both the acidic nature of the resource and the sector of the resource with neutral resource (as proven by medium term discharge tests of 3 wells) have been identified. While the acidic nature of the resource has not been explicited in the case study, it is discussed in the references cited. The argument on using acidic resource in generic terms needs to be qualified as there are acid resource (discharge pH<4) which can be used for power generation. With regard to the classification and suggestion that the project be classified as E3:F4.2:G1+G2+G3, The project has been tested via 10 wells. The commercial viability of acidic geothermal resource (as for as many conventional geothermal development) remains the main issue, due to low prevailing market power cost. Initiatives are underway to secure government incentives for this type of renewable energy resource. The Working Group will therefore maintain the current classification. The Working Group will add these clarifications to the Alto Peak application example.
	7.13	**Baslay Dauin Project (Pages 68-72)** Again an acidic geothermal field which has not been as widely drilled as Alto Peak and it is not then clear whether the acidity is distributed occasionally, or widely throughout the reservoir. The same issues crop up with a	Baslay-Dauin is another project on-hold. Wells drilled in the area indicated evidence of neutral resource; the size of development in the area has yet to be established.

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		Monte Carlo assessment being made of hot acidic fluids which cannot be commercially utilized for their heat content because of their chemistry. We nonetheless agree with the evaluators view on this project being an E3: F2.2: G1+G2+G3.	The Working Group will add these clarifications to the Baslay-Dauin application example.
Michael Forrest	8.1	I have a number of comments regarding the classification of geothermal resources under UNFC. I accept that a method of classification is useful in evaluating geothermal resources in a similar manner to those of other energy and mineral deposits. UNECE Expert Group on Resource Classification gives a series stages in the knowledge and commercial viability of solid mineral and mineral energy deposits. These deposits are finite in the sense that the amount of material, the resource, has been measured and is fixed in place. All mineral and hydrocarbon resources with the exception of very minor gas resources are the product of past geological activity and therefore finite even if no accurate resource figure is known. Furthermore after quantification and even extraction the economic case for any mineral deposit is dependent on the price of the mineral production at any one time. Nevertheless the CRIRSCO resource estimates are converted to reserves by the application of modifying factors such as economic, social and technical. I note from the 12 case histories a distinction between those operations/projects that are used for space heating and those for electrical power generation. They require different temperature and flow regimes and could be regarded as separate deposit types. Those geothermal resources exploited by GSHP are dependent on marginally elevated heat flow from the earth usually at around 100 m. This heat flow can be diminished by over extraction as noted in examples reducing the output for space heating. It can be restored by a reduction in heat extraction rate to below that of the geological heat flow. GSHP can also be used in horizontal pipeworks supplying heat from what is essentially solar rather than geothermal energy. In a number of cases over extraction can actually freeze the ground in both vertical and horizontal GSHP systems.	Unfortunately, this contribution does not prompt to any specific comment for The Working Group to react to.

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		Although it is correct to classify the energy source as renewable there is a time constraint that influences the resource. Although the case histories give time intervals for energy production eg 6MW over 25 years, that is the rate of extraction, a value in the classification of the maximum output of the geological resource before a reduction in output is noted would enable the resource to be a reserve akin to other mineral and hydrocarbon resource/reserves. Those higher temperature geothermal resources that can be used for electrical power generation are based upon hot rocks at much lower crustal levels. As the heat flow is driven by volcanic or granitic (often with a radiogenic input) rocks the volume of rock and its link to deep crust or then asthenosphere the heat flow can be regarded as constant over human time scales. Although great advances have been made in determining rock characteristics at depth what actually exists between injection and production wells sometimes leads to loss of pumped fluids into the surrounding geology. A project in Cornwall UK failed because of leakage when pressurised. Values of rock porosity could be include in the classification, or at least highlighted if not known. All of these factors would help to bring the geothermal resource in alignment with mineral resources. Both space heating and electrical generation geothermal resources are critically determined by the markets in a way that other mineral deposits are not. This is a reflectance of the local market for the recovered energy. In GSHP the energy distribution has a very limited geographic distribution directly related heat losses in transmission. As the North Rhine Westphalia example show buildings are required near the source for the energy to be exploited. District space heating is only applicable in colder climates. Electrical generation systems fare better, although recover less energy, as power lines can feed national grids. Like other relatively low value resources significant infrastructure costs are required. Those too far from significant markets are stranded deposits just like those in a similar environment, the South Australian	

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		example being a case in point requiring an atypical market for the power. These differences in classifying geothermal resources relate to the fact that it is difficult to transport the product (energy) on a global scale. This does not apply to oil or minerals although natural gas has similar problems overcome by expensive pipelines or liquefaction. These factors are more important in geothermal products than they are in solid minerals or oil.	
Trin Intaraprasong, Department of Mineral Fuels, Thailand	9.1	In the E/F/G Table, E is good. F needs minor revisions on Additional Geothermal Energy Context. G needs major improvements on Additional Geothermal Energy Context such as definition of discovery.	The Working Group would like to point at section I.K for an explanation of known versus potential Geothermal Energy Sources and at the table in Annex I for additional Geothermal Energy context with regards to G4.
Christopher Rochelle, British Geological Survey	10.1	This is a useful document as it aims to provide a set of common reference points with which to compare geothermal assessments. I like the use of the case studies to show how this might be implemented. Some of the areas covered are outside my area of expertise, so I have only a few comments. These are listed below. I realise that they may be slightly to one side of the aims of the report, but I raise them as I think they have a bearing on the subject.	Thank you.
	10.2	In terms of 'other geothermal products' (Section A). I note that these have the potential to make an important difference in terms of whether a geothermal project goes ahead, as they may make the difference between a project being sub-economic or economic. So though they may have little direct relevance in terms of power output, they may play a very important role in terms of being able to increase overall geothermal power development. This has been recognised by the European Commission by the recently funded CHPM2030 project which is considering production of combined heat, power and metals (http://www.chpm2030.eu).	Section I.A.6 states that "In the geothermal energy context, the Renewable Energy Source is the thermal energy contained in a body of rock, sediment and/or soil, including any contained fluids, which is available for extraction and conversion into energy products." Consequently, as stated in section I.A.7, "Examples of Geothermal Energy Products are electricity and heat. Other products, such as inorganic materials (e.g. silica, lithium, manganese, zinc, sulphur), gases or water extracted from the Geothermal Energy

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			Source in the same extraction process do not qualify as Geothermal Energy Products. However, where these other products are sold, the revenue streams should be included in any economic evaluation." Thus, the Geothermal Specification do allow for the revenue streams of these associated non-Geothermal Products to be included in the overall Project's economics.
	10.3.	In terms of 'other geothermal products' (Section A) and/or 'Multiple Energy Products' (Section H). These address producing heat, energy or physical products. But a concept exists (though not demonstrated yet) for using CO2 as a working fluid instead of water. One consequence of this, is reaction of CO2 with rocks and the trapping of the CO2 underground. Essentially, this represents one type of CO2 sequestration technology, and disposal of a waste product from another energy sector. The 'product' in this case would be a service, using up waste CO2. This could also have economic (and environmental) benefits, if linked to carbon credits or other such revenue stream for disposal of CO2. I suggest the wording of the text be checked to be flexible enough to include this concept should it become more developed.	The Working Group is fully aware of such concept. In this case, the Geothermal Product would still be the heat or electricity produced. Ultimate underground storage of CO_2 can be handled by the Specifications for the Application of the UNFC-2009 to Injection Projects for the Purpose of Geological Storage (see http://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrc/egrc7_apr2016/ECE.ENERGY.GE.3.2016.7_e.pdf). The Geothermal Specifications alone are not currently designed to handle hybrid energy projects.
	10.4	I could see no mention of 'heat storage' in the document. It appears to concentrate on natural thermal resources already in place. However, there is potential to use the geosphere for the (probably seasonal timescale) storage of waste heat – essentially creating an artificial geothermal resource. This could cover waste heat from conventional power plant, or excess heat at times of low demand (some types of conventional and nuclear power plant are slow to shut down, so disposal of waste heat could be necessary). Again, this concept is in its infancy, but it might be useful for the document to either include it specifically, or	**S**ection I.A.6 of the Geothermal Specifications state that "In the geothermal energy context, the Renewable Energy Source is the thermal energy contained in a body of rock, sediment and/or soil, including any contained fluids, which is available for extraction and conversion into energy products." The word "natural" per se' is not part of this definition and to some extent GSHP projects (covered by the Geothermal Specifications) rely on anthropogenic heat being put back underground, which is why a

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		allow the text to be flexible enough to include it should it be developed.	careful definition of the Reference Point is required – see the application examples in Annex II. Besides, although all forms of energy (natural or anthropogenic) contribute to the energy balance of the source, only the energy extracted from the source is classified as Geothermal Energy Product. The Geothermal Specifications are not currently designed to handle Projects that aim purely at temporary storage of anthropogenic heat underground.
	10.5	In terms of case studies. I like the range of different systems that these cover, though I wonder if it might have been useful to include one or two examples of the larger, perhaps better known high enthalpy systems.	A high-enthalpy example from Iceland will be added to the twelve application examples previously included with the Geothermal Specifications.
Professor Marinela Panayotova, University of Mining and Geology of Bulgaria,	11.1	The only thing I can say is "Thank you very much to Dr. Falcone and to all members of the Working Group of expert volunteers!" Especially useful, in my opinion, are the developed Decision trees.	Thank you.