Review Comments by Experts on Second Order Draft of Volume 2 of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
7462	2	4	215	216	this is an unchanged text but it states that only emissions from fossil fuels should be regarded in this chapter - however, biogas und charcoal are considered as biomass - furthermore, this general explanation would be better between the major header (line 210) and the first sub-header (line 211)	Jens Reichel	Accepted with modification	Implemented suggested change. Also included mention of fuel "transformation" in reference to subchapter 4.3.
3904	2	4	239	241	Exploration is neither mining or handling. The bullet is wrongly placed. Alternatively we can add "and Exploration" at the top so that it reads "Coal Mining, Handling and Exploration"	Andrea TILCHE	Accepted	Good suggestion. Amended heading as suggested.
6958	2	4	267	280	Coal mining smetimes follows a pattern where mining stops for some years and then resumes either in response to demand or to price or legislation changes. In such cases the mine may not apper as abandoned or closed. If emissions are estimated on the basis of mined tonnage then there may be unerestimation of fugitive emissions. It may be useful for the guidelines to clarify how such situations may be handled.	Nobert Nziramasanga	Rejected	Abandoned mines methodology is out of scope.
3906	2	4	303	304	Please revisit this sentence. It sounds like a contradiction	Andrea TILCHE	Accepted	Few changes have been made.
248	2	4	364	369	Equation 4.1.2 seems to be incorrect in part of CO2 emissions. Amount of CO2 generated by CH4 flaring has other chemical nature and is not included in the CO2 balance/emissions from coal mining when coal gas was firstly generated. So, probably, "-" has to be changed to "+" for CO2 contained in the secondary gas from coal gas thermal impact. later on, on the lines 399-400 it's written, "since it is already included via the emission factors, hence no subtraction or addition is needs", if so, CO2 from CH4 that could be flared but was not (just emitted) has to be included with "+". Sorry, if I'm totally wrong, the description seems still very confused especially taking into account the specific with EFs in this subchepter. It needs more precise description. One more thing, for CH4, post-mining emissins are inclded. Why not for CO2?	Sergii Shmarin	Accepted with modification	Please note that: ① Equation 4.1.2 is to be used along with Equation 4.1.1, in order to adjust for methane utilisation and flaring for Tier 1 and Tier 2 approaches (see lines 379-380); therefore, "emissions from underground mining CO2"in Equation 4.1.2, is supposed to be calculated with Equation 4.1.1 and the CO2 emission factor there already covers all the CO2 contained in the seam gas that are likely to be released from underground mining activities, hence no more subtraction or addition adjustment is needed;② the Equation has been modified and the amount of CO2 generated by methane flared or catalytically oxidised now is included with "+";③ Wording of the text has been further refined to avoid misunderstandings.④ why CO2 emissions from post-mining activites are not inclded in Equation 4.1.2? Theoretically it should, however there is yet no methodology for that, neither in the 2006 IPCC GL nor in the Refinement. Therefore, we have to ignore CO2 emissions from post-mining activites in the Equation.
658	2	4	385	386	Equation 4.1.2 elaborated for inclusion CO2: It looks like the equation for reporting CO2 emissions for underground mining activities may result in under-estimation of CO2 emissions, if those originate from recovered coalbed gas burned for energy purposes (note that CO2 emissions from combustion for energy purposes of recovered coalbed gas are covered in Chapter 2, Stationary Combustion, of the 2006 Guidelines). It is proposed that the authors cross-check Equation 4.1.2 and supporting text to avoid inconsistency with Chapter 2, Volume 2, of the 2006 Guidelines.	Mikhail Gitarskiy	Rejected	The new text under Equation 4.1.2 in the Refinement has explained why "the amount of CO2 contained in the gas recovered and utilized for energy production" should be subtracted. If seam gas is recovered and utilized for energy production purpose, then the CO2 contained in the seam gas is held in the recovered gas until the later is being consumed. This amount of CO2 (along with other carbon-containing components in the recovered gas) would be reported under other relevant source categories (instead of fugitive emissions from mining activities) depending on the end-use characteristics of the recovered gas. There is no underestimation of CO2 emssionns in Equation 4.1.2, or any inconsistency between the Refinement and the Chapter 2, Volume 2, of the 2006 Guidelines.
3908	2	4	424	426	Is it correct to use the word "CANNOT"?. Would it not be better to say "there are no known methods as of now"	Andrea TILCHE	Accepted with modification	Text has been amended to reflect the comment. Also amended same issue in lines 728-729.
3910	2	4	433		What are general emission factors?	Andrea TILCHE	Accepted	The adjective "general" has been removed.
2750	2	4	439	440	The text of the flow diagram is not distinguished	Poot-Delgado Carlos Antonio	Accepted	The figure was revised for the legibility of the text in the figure.
2886	2	4	443	444	The text of the flow diagram is not distinguished	Poot-Delgado Carlos Antonio	Accepted	The figure was revised for the legibility of the text in the figure.
250	2	4	443	444	There are points (".") or other signs in the end text part of each block except for block "are mine-specific data available" in the fig. 4.1.1a. Please, add "?" or delete symbols in other blocks.	Sergii Shmarin	Accepted	"?" has been added.
256	2	4	458	464	Please, unify the units in the subchapter. Here it's writen as m3 tonne-1 and m3tonne-1 on line 371.	Sergii Shmarin	Accepted	The mistake in line 371 has been modified.

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1970	2	4	466	3120	Annex 4A.1 defines that the default EFs are given at a standard conditions of 15°C and 101.325 kPa (1 atm); while Chapter 4.1 (please refer to line 466, 497, 530, 599, 758, 781, 805, 884, 1001, 1051, 1195, 1215) provides the densities of CH4 and CO2 at 20° C and 1 atmosphere pressure. The reviewer would suggest to keep 20°C and 101.325 kPa (1 atm) the standard conditions for natural gas system (meanwhile for oil system, the standard condition could still be 15°C and 101.325 kPa), since the original 2006 GL has already made these choices.	DAN YU TIAN	Rejected	In practice, oil and gas system is the aggregated industry. Moreover, several categories have no distinctions made between oil EFs and gas EFs (e.g., for abandoned wells). For that point, it is reasonable to keep all 4.2 chapter data consistent with standard conditions as 15 degrees and 1 atm.
252	2	4	478	480	There is a number of punctuation errors. Please, fix it.	Sergii Shmarin	Accepted	2 times comma deleted. 1 semicolon replaced by colon.
2888	2	4	481	484	Reorder bibliographical citations by year and verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted with modification	Bibliographical citations have been reordered by year; However, the bibliographic citation format, which is required to be Environmental Conservation style, should be unchanged.
254	2	4	481	484	The References are not structured. For example, what's that? Who personally did it, the people of Czech Republic, all togather for "Czech Republic 2017"?	Sergii Shmarin	Accepted	CHMI (2017)National Greenhouse Gas Inventory Report of the Czech Republic (reported inventories 1990- 2015). Czech Hydrometeorological Institute, Ministry of the Environment of the Czech Republic, In: p. 491. SHMU and Ministry of Environment (2017) National Greenhouse Gas Inventory Report 1990 – 2015 to the UNFCCC and the Kyoto Protocol., Slovak Hydrometeorological Institute and Ministry of Environment of the Slovak Republic, 2017 In: p. 448. Ministry of the Environment and Spatial Planning (2017) Slovenia's National Inventory Report 2017. Ministry of the Environment and Spatial Planning, Ljubljana 2017 In: p. 353.
258	2	4	498	498	I propose to change the title of the reference from (GOST 2015) to other one. Because, "GOST" means just "State Standard". Someone or certain institution from certain country had to perform it. It's just a typical abbreviation in former USSR countries.	Sergii Shmarin	Rejected	The density of real gases for certain pressure and temperature actually obtains from real gas state equation. Really the values of compressibility factor originally finds from experiments or from calculation, as example by virial equation. But we are not going to add any parts of thermodynamics into Chapter 4.1 so there is no matter who and where originally applied the operation of multiplication and division to obtain the CO2 density at 20 °C and 1 atm.
4594	2	4	498	498	The density is listed as 1.839E-06 in line 498 but as 1.84E-06 in line 782	Ole-Kenneth Nielsen	Accepted	Changed density value in line 498 to 1.84.
1968	2	4	498	782	The density of CO2 differs between line 498 (1.839 ● 10-6 Gg m-3) and line 782 (1.84 ● 10-6 Gg m-3). Please make this value consistent. The reviewer prefers the later.	DAN YU TIAN	Accepted	Changed density value in line 498 to 1.84.
3912	2	4	499		Are average emission factors the same thing as default emission factors?	Andrea TILCHE	Noted	The text refers to the Average emission factor listed in row 494 above. Have now inserted "CO2" to make it clearer.
260	2	4	499	499	Pease, unify the words "Emission Factor/s". With capital letter or with small letter.	Sergii Shmarin	Rejected	"emission factor" left as small letters in general text. Left as capital where used in relation to defining terms in equations.
262	2	4	504	504	Typical for this subshapter. Is the term "basein-specific" a common practice term for the whole part of 2019 Refinement and IPCC 2006?	Sergii Shmarin	Noted	Yes, the term "basin-specific" is a common practice term used in Subchapter 4.1 for the existing 2006 Guidelines and the 2019 Refinement. It refers to geological coal basins and that individual coal basins may have distinctive coal and gas characteritistics. Therefore it may be beneficial to develop emission factors for individual basins, rather than a single country-specific emission factor. Of course this will vary depending on the countries circumstances and availablility of data.
264	2	4	714	718	In equation 4.1.6 CO2 underestimation looks to take place because for surface activity surface atmospheric layer CH4 has to be in place. Compared with CH4 emissions, this fact is ignored. So, CH4 and CO2 approaches seem to be not comparable logically.	Sergii Shmarin	Accepted	Have added a term for "Post-mining emission of CO2" in Equation 4.1.6 for completeness. Have also added clarifying text in 4.1.4.1 noting that while no default method is provided for estimating Post-mining emissions of CO2 , countries can provide their own country-specific emission estimate.

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660	2	4	717	717	Equation 4.1.6: The equation for reporting CO2 emissions from surface coal mining seems incomplete. It is proposed that the authors further elaborate on it.	Mikhail Gitarskiy	Accepted	Have added a term for "Post-mining emission of CO2" in Equation 4.1.6 for completeness. Have also added clarifying text in 4.1.4.1 noting that while no default method is provided for estimating Post-mining emissions of CO2 , countries can provide their own country-specific emission estimate.
3914	2	4	728	729	Same comment as in lines 424 to 426	Andrea TILCHE	Accepted with modification	Text has been amended to reflect the comment.
3916	2	4	744	745	This sentence is repeated is repeated in 764. I don't see the reason for the repetition.	Andrea TILCHE	Accepted	Duplicate sentence has been deleted in lines 744 to 745.
2890	2	4	767	767	Verify bibliographic citation	Poot-Delgado Carlos Antonio	Accepted	2 punctuation errors have been found and fixed. "Republic of Kazakhstan" has been changed into "Ministry of Energy of the Republic of Kazakhstan".
266	2	4	768	768	References. Please, clarify for Kazakhstan. The people of this country used to work hardly and alltogather but.	Sergii Shmarin	Accepted	Ministry of Energy (2017) National report of the Republic of Kazakhstan on the inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol for 1990-2015. Ministry of Energy of the Republic of Kazakhstan, Astana 2017, In: p. 393.
4548	2	4	782	782	The denisty of CO2 should be the same for both underground and surface mining. The value here is rounded to two decimals, while the value on line 498 is provided with three decimals.	Ole-Kenneth Nielsen	Accepted	Changed density value in line 498 to 1.84.
2658	2	4	783	784	"it is good practice to use the low end of the specific emission range for those mines with average overburden depths of less than 25 meters and the high end for overburden depths over 50 meters." The source should be indicated here.	Xiangzheng Deng	Rejected	Text guidance has been made to be consistent with that for corressponding, existing methane surface mining above. It is also consistent with the fundamental understanding that gas generally increases with depth.
1938	2	4	785	785	The average emissions factor was not modified adequately. The average value should be modified from 0.65m³/tonne to 0.44m³/tonne.	DONGKOO KIM	Accepted	Error identified. The text has now been updated.
2892	2	4	891	891	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	No action can be taken because comment is out of scope of 2019 Refinement.
276	2	4	978	979	Sorry, table 4.1.5 is shaded but for me it still looks not 100 % logical for low level of gaseous mines. The older mine, less coal gas would be emitted, Ok. But, if in my country all the coal mines are not gaseous. So, it doesn't depend on age. It means, that the low level is always 0. Or it has to be mentioned that this table is only for gaseus mines.	Sergii Shmarin	Rejected	No action can be taken because comment is out of scope of 2019 Refinement.
6954	2	4	978	979	Table 4.1.6 (TIER 1 – ABANDONED UNDERGROUND MINES EMISSION FACTORS) should be extended for further inventory years or it should be completed with the appropriate equation to allow to be calculated the new inventory year - after 2016. In the latter case a possible solution would be the use of EQUATION 4.1.12 (with default values for "a" and "b") multiplied by default "Emission rate at Closure".	Klára Tarczay	Accepted	The abandoned mines methodology is out of scope. However it is acceptable to update this table for years beyond 2016.
4550	2	4	978	979	Currently, the tier 1 EF table only lists inventory years until 2016, which has already been reported. As the values are far from constant, would it not be prudent to expand the list of inventory years to future proof these guidelines? This could be done be including years up until 2030.	Ole-Kenneth Nielsen	Accepted	The abandoned mines methodology is out of scope. However it is acceptable to update this table for years beyond 2016.
1940	2	4	979	979	No emissions factors were presented for the period after 2016. Emissions factors were provided only from 1990 to 2016 in Table 4.1.6. It will be a nice alternative to present the emissions factors in a similar way of Tier 2 approach.	DONGKOO KIM	Accepted	The abandoned mines methodology is out of scope. However it is acceptable to update this table for years beyond 2016.
268	2	4	981	981	Table 4.1.7 is shaded. Anyway, please fix the word "Eqn" if possible.	Sergii Shmarin	Accepted	"Eqn" replaced by "Equation".

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662	2	4	1162	1169	Due to economic reasons, it may not be necessary to produce new boreholes to assess annual changes in coal reserves, especially if the coal basin is subject to permanent exploration and production. Besides, other exploration methods exist, which do not require construction of boreholes. Consequently, changes in and augmentation of coal reserves do not directly relate to number of exploration boreholes. Meanwhile, the number of exploration boreholes constructed annually seems more accuarte and adequate information on corporate (national) exploration efforts. These data are available from companies and national stastic offices. It is proposed that the authors reconcile the guidance on estimating GHG emissions from coal exploration based on augmentation of coal reserves and develop the guidance based on the information on exploration boreholes instead.	Mikhail Gitarskiy	Accepted with modification	Major coal producing countries do present coal resources on an year-to-year basis. These may be ascertained from several governmental and non-governmental reports and links. Therefore, augmentation of coal resources on annual basis can be obtained to a large degree of accuracy. Number of exploration boreholes drilled annually seems to be a better option. However, this data is not readily available in national statistics. Therefore, we have considered this approach in a Tier 3 method. Tier 1 and Tier 2 methods based on augmentation of resorces and depth-wise augmentation of resorces respectively, can be used if data number of boreholes drilled is not available or cannot be collected from coal exploration agencies or corporates.
1972	2	4	1164	1165	Reference should be provided to support this method of using “the augmentation of coal resources” as activity data for exploration boreholes.	DAN YU TIAN	Accepted with modification	Please see Section 4.6.1.2 CHOICE OF EMISSION FACTORS. In the last paragraph of Tier 1 it has been stated that information on fugitive methane emission from coal exploration boreholes is not usually readily available. The basis is expert judgement.
3918	2	4	1170		The questions/sentences in the decision tree diagrammes should begin with capital letters. Some are correct and some are not. It should be uniform. Furthermore, Fig 4.1.4 is not mentioned in the text.	Andrea TILCHE	Accepted	Decision tree updated.
270	2	4	1170	1170	Please, unify punctuation and capital letters in the blocks.	Sergii Shmarin	Accepted	Decision tree updated.
664	2	4	1170	1171	Figure 4.1.4: The decision tree seems inconsistent with inventory improvement concept, which builds upon key category analysis. The question, if the category is key, stands in the beginning of decision trees in the 2006 Guidelines and thus, guides further actions of inventory compilers. However, it is not included in the present structure of decision tree. To maintain concictency in decision tree structure, it is proposed that the authors include key category identification in Figure 4.1.4. It is also proposed to include reference to Figure 4.1.4 in the text of section 4.1.6.1.	Mikhail Gitarskiy	Accepted	Decision tree updated. Reference inserted in line 983.
6138	2	4	1173	1216	I appreciate that the authors clarify the rationale of the default emission factors of coal exploration under line 1175. However, considering the factors are as per expert opinion, I consider they have large uncertainty.	Naofumi Kosaka	Accepted	Clarified in section 4.1.6.2.
3920	2	4	1174		"No results are available in the literature" should read "no information is found in the literaure.	Andrea TILCHE	Accepted	Modified as suggested by the reviewer.
666	2	4	1179	1221	The description of tiers 1 to 3 and of equations 4.1.14 and 4.1.15 is not relevant to sub-section 4.1.6.2 (Choice of Emission Factors). It is proposed that the authors move the description of tiers and equations to sub-section 4.6.1 that deals with methodological choice. Description of choice of emission factors is retained in sub-section 4.1.6.2.	Mikhail Gitarskiy	Accepted	Text amended. The description of tiers and corresponding equations have been moved sub-section 4.1.6.1 and the emission factors have been retained in the sub-section 4.1.6.2.
668	2	4	1182	1204	In the Equations 4.1.14 and 4.1.15, the estimation of methane emissions from coal exploration builds on augmentation of coal reserves. The proposed estimation method looks incorrect, because as such, coal reserves are not the sources of greenhouse gas emissions. The emissions occur with the start of mining activities. With this, a simple presence of augmented coal reserves cannont be used for emission estimation. The exploration boreholes constructed annualy are indeed the emission categories. However, the equations 4.1.14 and 4.1.15 are currently designed in a way that annual augmentation of coal reserves serves the activity data for greenhouse gas emissions released through the boreholes. It is proposed that the authors reconcile the activity data parameters in the equations 4.1.14 and 4.1.15 and replace them with the number of exploration boreholes. Furthermore, it is proposed that the authors provide default emission factors per exploration borehole to enable greenhouse gas estimations from coal exploration.	Mikhail Gitarskiy	Accepted with modification	Major coal producing countries do present coal resources on an year-to-year basis. These may be ascertained from several governmental and non-governmental reports and links. Therefore, augmentation of coal resources on annual basis can be obtained to a large degree of accuracy. Number of exploration boreholes drilled annually seems to be a better option. However, this data is not readily available in national statistics. Therefore, we have considered this approach in a Tier 3 method. Tier 1 and Tier 2 methods based on augmentation of resorces and depth-wise augmentation of resorces respectively, can be used if data number of boreholes drilled is not available or cannot be collected from coal exploration agencies or corporates.

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6020	2	4	1190	1193	What would be the recommendation for choosing emission factors? It would be better if this were indicated in the text, as in the other sections of this chapter, which show intervals between low and high values.	RENATA GRISOLI	Accepted	Indicated in the text.
1974	2	4	1197	1204	Concerning the “Depth-wise Approach”, it may not be a Tier 2 approach since it applies default EFs.	DAN YU TIAN	Accepted	Necessary coorections have been made.
1976	2	4	1197	1213	Reference should be provided to demonstrate scientific rationality of this method, as well as source of these default emission factors. If no literature is available to support the methodology and/or the default emission factors, this method shouldn’t be provided in the body of the 2019 Refinement.	DAN YU TIAN	Noted	The depth-wise approach has been merged with the global average approach. Additional detail has been provided (lines 1054 to 1060) on the source of the emission factors and method (expert judgement).
272	2	4	1200	1204	Equation 4.1.15. The symbol of sum without numbers of depth types (for example, n=1…4), looks not so aesthetically attractive. Probably, symbolic clasification of depths would be in place.	Sergii Shmarin	Accepted	Number of depth types has been furnished.
7542	2	4	1222	1231	In the draft is written that augmentation of resources or new addition of resources in the year may be used as Activity data. From the methods is not clear if activity data in tonnes year -1 should be used as a augmentation only of coal or lignit and waste, which was minied together with lignit should be neglected.	Eva Krtkova	Rejected	Mining of coal or lignite is not a part of exploratory borehole drilling.
1978	2	4	1222	1231	There are different categories of coal resources (please refer to “United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009”), the authors should clarify the activity data refers to augmentation or new addition of what category of “Resource”, to avoid ambiguity.	DAN YU TIAN	Accepted	Additional detali on coal resources has been added, see lines 963-982.
6140	2	4	1222	1231	I suggest that the authors clarify the definition of "resources" used for the activity data of coal exploration to avoid a readers' confusion. The following reference is useful: BGR Energy Study 2017, pages 174 and 176; available at https://www.bgr.bund.de/EN/Themen/Energie/energie_node_en.html	Naofumi Kosaka	Accepted	Additional detali on coal resources has been added, see lines 963-982.
670	2	4	1226	1226	It is proposed to remove text in line 1226, because it may be incorrect, if augmentation is not made annually, otherwise coal reserves decrease from year to year.	Mikhail Gitarskiy	Rejected	An alternative equation is unavailable.
3922	2	4	1244		The word chapter is wrongly spelt.	Andrea TILCHE	Accepted	Mistake corrected!
8454	2	4	1244	1244	Please check the correction of word "Chapter".	Pornphimol Winyuchakrit	Accepted	Mistake corrected!
6022	2	4	1244	1244	It is necessary to correct the orthography of the word: "Chapter 5".	RENATA GRISOLI	Accepted	Mistake corrected!
3924	2	4	1260	1261	"….uncertaintly be in the range…." there is a word missing	Andrea TILCHE	Accepted	"may" inserted now it written as: known, uncertainty may be in the range of ±1 – 2 percent.
3926	2	4	1264		It is not clear which two type of sources are referred to in this sentence	Andrea TILCHE	Accepted	Sentence rephrased… now it´s written as: As combination of these effects the uncertainties in Tier 1 approach may be greater or smaller by a factor of 2.
4552	2	4	1273	1273	The sentence needs some work, e.g. Two sources have been identified with potential emissions, but are not included with a methodology in these guidelines. These two sources are …	Ole-Kenneth Nielsen	Accepted	Text has been amended to incorporate the suggested wording.
2044	2	4	3893	3895	China State Administration of Coal Mine Safety. (2012) Compilation of Measurement Data for Classification of	DAN YU TIAN	Noted	This comment is incomplete and doesn't convey any useful message.

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6960	2	4			It is common that GHG inventory estimations are improved by adopting measured emission factors to achieve tier 2 or higher emission factors. In coal mining upgrading of default to higher emission factors may be distorted by measuring emissions from mines that have been in operation for some time. This is because gas would have escaped from unmined seams more than during before mining commenced. Even though this likely addressed during the research process it may be useful to list such cases as areas needing special attention.	Nobert Nziramasanga	Noted	No action can be taken because comment is out of scope of 2019 Refinement.
274	2	4	1557	1558	Please, look once more. Probably, it's better to use "NA" instead of "NO" based on Decision 24/CP.19 (Iin force).	Sergii Shmarin	Rejected	The UNFCCC and the IPCC are different processes even when emissions estimates submitted to UNFCCC are based on IPCC methodology. Most importantly, is that the reviewer misunderstood the definition of “NA”, which belongs to categories that occur but emissions from them are not expected. So the decision tree is correct in this regard.
278	2	4	1823	1828	The leters in the equation are very smal. Could you please make it bigger.	Sergii Shmarin	Rejected	Such formatting issues will be addressed with the final report.
280	2	4	1829	1830	Table 4.2.3 looks not so aesthetically attractive.	Sergii Shmarin	Accepted	
282	2	4	1945	1946	Table 4.2.6. For the uncertainties of -50-130 % the rounding level seems too "accurate" especially for the values "5.848" and "0.261" as well as their sizes differ (stylistically).	Sergii Shmarin	Accepted	Changed to two digits.
284	2	4	1945	1946	For aviation fuel (gasoline) the uncertaint might be higher then for diesel.	Sergii Shmarin	Rejected	Yes, it is right. But this EF is a aggragated data for oil refinary.
286	2	4	2018	2019	Could you, please, check once more the units of measurement for the table 4.2.7. Values per well may be a potential mistake (compared with mass units).	Sergii Shmarin	Accepted	We have rechecked the values and they are correct.
288	2	4	3136	3137	Please, change commas to points where necessary.	Sergii Shmarin	Rejected	Current use is consistent with style guidelines.
672	2	4	1546	1564	Decision trees in Figures 4.2.2 to 4.2.5 are inconsistent with the concept of preparation and improvement of national inventories, which builds upon key category analysis. In the 2006 Guidelines, the question if the category is key, stands in the beginning of the decision tree, thus, guiding further actions of inventory compilers. However, in the decision trees in Figures 4.2.2 to 4.2.5, this question is in the bottom, which seems inconsistent with general guidance in Volume 1 of the 2006 Guidelines. It is proposed that the authors reconcile the decision trees and make them consistent with the general guidance provided in Volume 1.	Mikhail Gitarskiy	Rejected	The question on key category is at the end in practically almost all decision trees in the energy volume. Therefore this decision tree is in line with almost all decision trees in volume 2.
674	2	4	1613	1614	Table 4.2.1 provides description of operations in oil and gas industry. It is proposed to move it to section 4.2.2.1, which is about methodological choice. It is further proposed to include sub-titles "Operations with natural gas" and "Operations with oil" in table 4.2.1 to improve its clarity.	Mikhail Gitarskiy	Accepted with modification	See comment No. 6690.
676	2	4	1823	1828	It is proposed that the authors move Equation 4.2.9 and related text to methodological choice section (Section 4.2.2.3). It is further proposed that the authors include the reference to equation 4.2.9 in the text of the 2019 Refinement.	Mikhail Gitarskiy	Accepted with modification	1 - Section 4.2.2.2 contains recommendations on method (Tier) choice and common equations for Tier 1, which can be applied to any category. Section 4.2.2.3 is devoted to EFs choice. Equations of section 4.2.2.3 are aimed to clarify application of the EFs. Reallocation of the equation is not reasonable. 2 - The reference to relevant equation has been included in the text.
678	2	4	1829	1830	It is proposed that the authors check the units in last column of Table 4.2.3. It looks like some parameter is missing for the units for Oil exploration.	Mikhail Gitarskiy	Accepted	Correction made.
680	2	4	1902	1964	It is proposed that the authors move Equations 4.2.10, 4.2.11 and 4.2.12 together with their related text to methodological choice section (Section 4.2.2.3). It is further proposed that the authors include references to equations 4.2.10 to 4.2.12 in the text of the 2019 Refinement.	Mikhail Gitarskiy	Accepted with modification	1 - Section 4.2.2.2 contains recommendations on method (Tier) choice and common equations for Tier 1, which can be applied to any category. Section 4.2.2.3 is devoted to EFs choice. Equations of section 4.2.2.3 are aimed to clarify application of the EFs. Reallocation of the equation is not reasonable. 2 - The reference to relevant equation has been included in the text.
682	2	4	1920	1924	Equation 4.2.11 seems incomplete. It is proposed that the authors cross-check the equation and revise it.	Mikhail Gitarskiy	Accepted	Changed.

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684	2	4	2058	2062	It is proposed that the authors move Equation 4.2.13 and related text to methodological choice section (Section 4.2.2.3). It is further proposed that the authors reconcile the equation 4.2.13 to include the legend. Furthermore, it is proposed to include the emissions from natural gas flaring in the Equation 4.2.13, if appropriate.	Mikhail Gitarskiy	Accepted with modification	1 - Section 4.2.2.2 contains recommendations on method (Tier) choice and common equations for Tier 1, which can be applied to any category. Section 4.2.2.3 is devoted to EFs choice. Equations of section 4.2.2.3 are aimed to clarify application of the EFs. Reallocation of the equation is not reasonable. 2 - Legend to the equation has been included in the text. 3 - It it assumed that flaring is already covered by EFs.
686	2	4	2063	2063	Table 4.2.9: It is not clear from the Table 4.2.9 and supporting text, what operations (emission categories) are included in the emission factor for conventional gas exploration. In particular, it is not clear, if the natural gas flaring is included in the aggregate category (note that in the 2006 Guidelines a separte emission factor was provided for natural gas flaring). It is proposed that the authors clarify, if natural gas flaring is included in the emission factors referred to in Table 4.2.9.	Mikhail Gitarskiy	Accepted with modification	line 1890 we state: “In the table below, several options for onshore exploration emission factors inclusive of venting, flaring, and leaks are presented.”
688	2	4	2063	2063	It is proposed that the authors cross-check units for emission factors in the last column of Table 4.2.9. In particular, it seems that the indication of number of wells is not included in description of units in the last column of the table.	Mikhail Gitarskiy	Accepted	Changed labels to clarfy that it’s new gas wells drilled in a year.
690	2	4	2110	2203	It is proposed that the authors move to methodological choice sub-section 4.2.2.3 Equations 4.2.14 to 4.2.17 together with correponding text. It is further proposed that the legends are provided for the Equations 4.2.14 to 4.2.17.	Mikhail Gitarskiy	Accepted with modification	1 - Section 4.2.2.2 contains recommendations on method (Tier) choice and common equations for Tier 1, which can be applied to any category. Section 4.2.2.3 is devoted to EFs choice. Equations of section 4.2.2.3 are aimed to clarify application of the EFs. Reallocation of the equation is not reasonable. 2 - Legend to the equation has been included in the text.
692	2	4	2063	2205	As follows from Tables 4.2.9 to 4.2.12, default emission factors for on-shore exploration and production of natural gas were developed based on the data from one geographical region which is North America. However, the guidance in the 2006 Guidelines and previous IPCC inventory guidelines aims at coverage of all geographical regions, where such human activites occur. To enhance geographical coverage of natural gas operations in the 2019 Refinement, it is proposed that the authors include in Annex 4A.2 default emission factors for gas operations disaggregated by major geographic regions, where such operations occur. The default emission factors for natural gas operations in East Europe and West Asia are provided in the attached file. It is proposed to include them in the Annex 4A.2.	Mikhail Gitarskiy	Accepted with modification	1) Add a sentence on line 1561-1564. "While the emission factor options are meant to cover technologies and practices that are common in the oil and gas industries, technologies and practices can vary significantly. In addition, the accuracy of factors is dependent on the uncertainty of underlying data. A country should periodically assess changes in technologies and practices, and changes in available emissions data, and consider updating estimates using at least a Tier 2 approach, per good practice." 2) The data provided by the commenter will not be included in the text or annex, based on following reasons:① : the EFs provided from the commentor comes, basically, from a case study performed in 1998 in Western Siberia (Dedikov et.al, 1999) when on-site measurements were carried out to test the CH4 fugitive/venting rate in natural gas production and transmission systems. A new study (Uvarova et.al, 2017) performed in 2016 figured out the chemical composition of natural gas in the Russian Federation, including its CO2 content, by using fugitive/venting/flaring rates measured in 1998 (Dedikov et.al, 1999) and CO2 EFs were developed.② a peer reviewed study in 2010 concluded the emission factors identified by (Dedikov et.al, 1999) is not applicable to reflect the real situation nowdays in this region. (S. Lechtenböhmer & C. Dienst (2010) Future development of the upstream greenhouse gas emissions from natural gas industry, focussing on Russian gas fields and export pipelines, Journal of Integrative Environmental Sciences, 7:S1, 39-48, DOI:10.1080/19438151003774463)
694	2	4	2205	2205	It is proposed that the authors cross-check units for emission factors in the last column of Tables 4.2.12 and 4.2.13 and make them consistent with the units provided in other tables, namely Tables 4.2.9 to 4.2.11.	Mikhail Gitarskiy	Accepted	Fixed the formatting on the last column.
696	2	4	2332	2333	It is proposed that the authors change the order of presentation of tiers in Table 4.2.14 to start with tier 1. It is further proposed that the authors elaborate on description of primary sources for tier 1.	Mikhail Gitarskiy	Accepted with modification	1) Changed the order of table 4.2.14. 2) Detailed description of primery sources for tier 1 is provided in section 4.2.2.3

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
698	2	4	2340	2340	It is proposed that the authors change the heading of Table 4.2.15 to "Activity Data Values Required for Use in the Tier 1 Approach to Estimate Fugitive Emissions from Oil and Gas Systems", which seems more appropriate to the content of the table.	Mikhail Gitarskiy	Accepted	Edited sentence to delete "Guidance on obtaining the"
710	2	4	3065	3103	It is proposed that the authors provide default temperature conversion factors for oil, similar with those provided for gas (Table 4A.1.1). The temperature conversion factors for oil should be provided on volume to volume and mass to mass basis for the major types of oils referred to in the 2006 Guidelines.	Mikhail Gitarskiy	Rejected	The conversion factors for oil can not be provided similar with those provided for gas. The conversion of oil may be performed on oil density basis. Oil density may vary in broad scale. There are around 30 pages of values of possible oil densities. Including these pages in the GLs is not reasonable. The references on documents, from which the densities may be taken, are provided.
712	2	4	3125	3128	It is proposed that the authors enhance description of disaggregation parameters in tables 4A.2.1 to 4A.2.5 in the Annex 4A.2, to explain how these were derived and to justify their values.	Mikhail Gitarskiy	Accepted	Added text.
714	2	4	3142	3143	The disaggregation for tier 1 of the emission factors for gas exploration and gas production is not included in the Annex 4A.2, while they are important segments of oil and gas industry being significant source categories for some countries. It is proposed that the authors develop desaggregation of tier 1 emission factors for gas exploration and production and include these tables in the Annex 4A.2.	Mikhail Gitarskiy	Accepted	Gas production disaggregation was already in SOD, edited annex to add other segments.
716	2	4	3149	3150	In the sub-section 4.2.2.3 of the 2019 Refinement, the default emission factors for onshore exploration and production of natural gas in Tables 4.2.9 and 4.2.10 were developed based on data from one geographical region which is the North America. The parameters for other geographical regions were not included. This resulted in limited geographical coverage of gas producing regions of the world. This approach is inconsistent with the concept of geographical coverage applied in the 2006 Guidelines and previous IPCC inventory guidelines. To enhance geographical coverage in the 2019 Refinement, it is proposed that the authors include in the Annex 4A.2 default emission factors for gas operations for major geographic regions, where such operations occur. The default emission factors for natural gas operations in Eastern Europe and Western Asia are provided in the attached file. It is proposed to include them in the Annex 4A.2.	Mikhail Gitarskiy	Accepted with modification	See comment No.692.
1942	2	4	1830	1830	Table 4.2.3 is hard to read because the head and body of the table are separated into several pages.	DONGKOO KIM	Accepted	
1944	2	4	1909	1909	Table 4.2.4 is hard to read because the head and body of the table are separated into several pages.	DONGKOO KIM	Accepted	
1946	2	4	1926	1926	Table 4.2.5 is hard to read because the head and body of the table are separated into several pages.	DONGKOO KIM	Accepted	
1948	2	4	2063	2063	Table 4.2.9 is hard to read because the head and body of the table are separated into several pages.	DONGKOO KIM	Accepted	
1950	2	4	2117	2117	Table 4.2.10 is hard to read because the head and body of the table are separated into several pages.	DONGKOO KIM	Accepted	
1952	2	4	2159	2159	Table 4.2.11 is hard to read because the head and body of the table are separated into several pages.	DONGKOO KIM	Accepted	
1954	2	4	2205	2205	Table 4.2.12 is hard to read because the head and body of the table are separated into several pages.	DONGKOO KIM	Accepted	
1956	2	4	2249	2249	Table 4.2.13 is hard to read because the head and body of the table are separated into several pages.	DONGKOO KIM	Accepted	

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
1958	2	4	2584	2584	Table 4.2.16 is hard to read because the head and body of the table are separated into several pages.	DONGKOO KIM	Accepted	
1980	2	4	1920	1924	Error in Equation 4.2.11, “Amarine tanks•” should be “Amarine tanks• EFmarine tanks”	DAN YU TIAN	Accepted	Changed.
1982	2	4	1928	1946	EU ETS as well as US EPA Mandatory GHG Reporting Guidance prove that there is an important emission source - coke burn-off emissions during catalyst regeneration in “1 B 2 a iv Refining”, it could be classified as a process venting. Do the emission factors for oil refining provided in Table 4.2.6 (as well as TABLE 4A.2.2) take into account the contribution of catalyst regeneration? If not, the reviewer would suggest to add some methodical descriptions for catalyst regeneration in section “1 B 2 a iv Refining”. Otherwise this emission source will be missing.	DAN YU TIAN	Accepted	A box has been provided to make this issue more clear.
1984	2	4	1974	1974	The reviewer would suggest to change “under 1 B 2 a iii 6” into “under 1 B 2 a vi other”, since the authors renew the IPCC code for fugitive emissions from oil and natural gas systems (see table 4.2.15 in the 2019 Refinement), the original IPCC code (at Table 4.2.1 in Volume 2 Chapter 4 of the IPCC 2006 Guidelines) should not be used any more.	DAN YU TIAN	Accepted	Changed.
1986	2	4	2058	2062	Error in Equation 4.2.13, “A• EFunconventional gas with flaring or recovery” should be “Aunconventional gas with flaring or recovery• EFunconventional gas with flaring or recovery”	DAN YU TIAN	Accepted	Corrected variable "A"
1988	2	4	2146	2147	The reviewer would suggest that emissions from town gas production processes should follow the methodological guidance developed in section 4.3.2.4 GASIFCATION TRANSFORMATION PROCESSES, and should be reported under “1 B 1 C Solid Fuel Transformation”. Furthermore, Volume 3 Chapter 3.11 “Hydrogen Production” clearly state that “emissions from production of hydrogen as part of mixtures with other gases, e.g., syngas, are not covered …”	DAN YU TIAN	Accepted	The reference has been changed to the transformation chapter. However, no explicit methodology can be found there. Although it is possible to use the outputs of CtL to Hydrogen Production, the process analysed in the 2019 Refinement 2006 Guidelines was restricted to the Syngas production.
1990	2	4	2253	2254	The reviewer would suggest to change “under 1 B 2 b iii 6” into “under 1 B 2 b vi other”, since the authors renew the IPCC code for fugitive emissions from oil and natural gas systems (see table 4.2.15 in the 2019 Refinement), the original IPCC code (at Table 4.2.1 in Volume 2 Chapter 4 of the IPCC 2006 Guidelines) should not be used any more.	DAN YU TIAN	Accepted	
2046	2	4	1349	1391	Footnote 3：Town gas (also called coal gas) is a manufactured gaseous fuel produced for sale to commercial and residential consumers.	DAN YU TIAN	Noted	No action can be taken because comment does not require any substantial reacti
2472	2	4	1920	1925	please check the formula	Mingshan Su	Accepted	Changed.
2474	2	4	2058	2062	please define the variables in the formula	Mingshan Su	Accepted with modification	Corrected variable "A"
2894	2	4	1546	1547	The text of the flow diagram is not distinguished	Poot-Delgado Carlos Antonio	Accepted	The decision tree has been updated with clearer text.
2896	2	4	1551	1552	The text of the flow diagram is not distinguished	Poot-Delgado Carlos Antonio	Accepted	The decision tree has been updated with clearer text.
2898	2	4	1557	1558	The text of the flow diagram is not distinguished	Poot-Delgado Carlos Antonio	Accepted	The decision tree has been updated with clearer text.
2900	2	4	1996	1996	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted	

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
2902	2	4	2010	2010	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted	
3406	2	4	1937	1945	In the Box4.2.1, it should make clear whether the emission from producing hydrogen as a intermediate product for oil refineries are already accounted for methodology of fugitive emissions from oil refinering	Eunae Seo	Rejected	The footnote in table 4.2.4c explains what processes are included in the EF - H2-production is not included in the EF.
3414	2	4	2146	2147	"Town gas originates from outgassing of hard coal under air exclusion in retort furnace or chamber kilns. Emissions from these processes are considered in Volume 3 Chapter 3.11 Hydrogen Production." But no estimation method is provided in Vol. 3, Ch. 3.11, since town gas is not pure H2 formed by complete oxidation of the feedstock. Suggest to rephrase or remove the reference to Vol. 3, Ch. 3.11.	Håkon F. Skullerud	Accepted	The reference has been changed to the transformation chapter. However, no explicit methodology can be found there. Although it is possible to use the outputs of CtL to Hydrogen Production, the process analysed in the 2019 Refinement 2006 Guidelines was restricted to the Syngas production.
3928	2	4	1425		There are some missing words in this sentence. It seems.	Andrea TILCHE	Rejected	We do not see any missing words in this line.
3930	2	4	1751		Should't there not be an "s" after "Factor"	Andrea TILCHE	Noted	No action can be taken because comment is out of scope of 2019 Refinement.
3932	2	4	1814	1815	The word "Conventional" needs to be defined	Andrea TILCHE	Rejected	The term “conventional” is defined both in line 1423 and later in the glossary.
3934	2	4	1857	1858	The sentence needs to be revisited. It would better read "onshore and offshore oil production".	Andrea TILCHE	Rejected	This comment is incorrect. Such change will confuse users.
3936	2	4	1880		The word "by" may be replaced by the word "through"	Andrea TILCHE	Accepted	Changed.
3938	2	4	1930		Please put the Box number	Andrea TILCHE	Accepted	Added box # to sentence.
3940	2	4	1945		Table 4.2.6 is not referenced in text - it seems.	Andrea TILCHE	Accepted	Added reference in text.
3942	2	4	1952		I do not understand the use of the word "regard"	Andrea TILCHE	Accepted	Changed.
3944	2	4	1968	1969	This sentence has no verb	Andrea TILCHE	Accepted	We revise; “This segment includes fugitive emissions (leaks, venting and flaring) from oil systems that are not otherwise accounted for in the other categories”
3946	2	4	2052		Please put the equation number in the text - just a suggestion	Andrea TILCHE	Accepted	Added equation number.
3948	2	4	2074		Please put the table number in the text - just a suggestion	Andrea TILCHE	Rejected	The number is already incldued in the text.
3950	2	4	2111		Please put the equation number in the text - just a suggestion	Andrea TILCHE	Accepted	
3952	2	4	2151		Please put the equation number in the text - just a suggestion	Andrea TILCHE	Accepted	Changed
3954	2	4	2195		Please put the equation number in the text - just a suggestion	Andrea TILCHE	Accepted	
3956	2	4	2237		Please put the equation number in the text - just a suggestion	Andrea TILCHE	Accepted	
3958	2	4	2443		Please a capital "T" in the word table.	Andrea TILCHE	Accepted	Edited
3960	2	4	2521		Please put the verb "is" after equipment	Andrea TILCHE	Accepted	Edited
3986	2	4	3126		"%" should be written in full	Andrea TILCHE	Accepted	Edited

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
4554	2	4	2225	2227	Usually, biogas will only have a similar methane content to natural gas if upgraded and even then it might not be the case. If it is not possible to derive and included biogas EFs, then it would be good in the text to describe the diffrences between biogas and upgraded biogas and also whether the CH4 EFs provided can be scaled using the CH4 content of the biogas	Ole-Kenneth Nielsen	Rejected	We assume that biogas was upgraded before added in natural gas distribution systems (see sentence in lines 2226-2227).
4556	2	4	1546	1547	Currently, the decision tree could be interpreted that if the category 'natural gas systems' is a KC, then you have to use tier 2 for everything. I.e. is gas exploration, production etc. makes 1B2b a KC then you should also use tier 2 for town gas distribution and various other minor sources within the category. I trust this is not the intention! In agriculture, this is solved by adding a further criteria that the subactivity should be significant (in the case of agriculture that the animal species is significant, to avoid having to use tier 2 for 15 horses because enteric ferementation is a KC due to cattle). I suggest adding some similar wording in this chapter when the decision tree covers many different sub-activities.	Ole-Kenneth Nielsen	Accepted	The decision tree has been updated to clarify that "significant" segments are treated differently from smaller subcategories. Significant is defined in volume 1.
4558	2	4	1551	1552	I think that the text 'If emissions from oil and gas operations are a key category, are contributions by the oil system significant' needs clarification. The decision tree is limited to crude oil production, so either the criteria could be whether crude oil production was a key category, or whether crude oil production is significant to the whole category, either 1B2 or 1B2a to be defined). Also, similar as to what is done in agriculture 'significant' should be defined.	Ole-Kenneth Nielsen	Accepted	The decision tree has been updated to clarify that "significant" segments are treated differently from smaller subcategories. Significant is defined in volume 1.
4560	2	4	1557	1558	See comment to decision tree for crude oil production. 'Significant' needs to be defined and it should reference specifically emissions from 'crude oil transport, refining and upgrading' (I wonder what happened to storage).	Ole-Kenneth Nielsen	Accepted	The decision tree has been updated to clarify that "significant" segments are treated differently from smaller subcategories. Significant is defined in volume 1.
4562	2	4	1563	1564	The decision trees are actually important as Parties to the UNFCCC are forced to follow them. I think, the authors should carefully examine all decision trees within Chapter 4 and check whether they reflect the intention of the authors. In this specific decision tree, the sentence 'If emissions from abandoned wells are a key category, are contributions from abandoned wells significant' makes no sense.	Ole-Kenneth Nielsen	Accepted with modification	Decision tree is deleted. It is assumed that decision trees on main categories (oil and gas industries) cover subcategory on abandoned wells.
4564	2	4	1762	1767	The decision to not have specific tier 1 EFs but rather letting the users pick and choose between several options, is a fundemental break with the whole purpose of the tier system. The default tier 1 EFs are for countries with no better data/knowledge and should therefore be easy to use. Inventory compilers will now be able to calculate two different tier 1 emission estimates and then having to choose one. Odds are both will be calculated and the lower value reported. It is good that the SOD in some cases add some guidance, e.g. for oil exploration (number of wells drilled is best), but this type of guidance should be availble in all instances where there is currently several options for AD. It would be a shame if the authors have given up on providing clear guidance and leaves it all to the users.	Ole-Kenneth Nielsen	Accepted with modification	We have provided clear guidance throughout the document on what EFs to use, based on technology and practices used in the country; we have noted that if a compiler is unaware of these then we recommend which of the EFs to choose. It is not unreasonable to expect a compiler to make some decisions, based on their own understanding of good practices.
4566	2	4	1829	1830	Table 4.2.3 only deals with onshore exploration, and I found no mention of offshore exploration in the text. It would be good to include offshore exploration in the table either with default EFs or with NA/NE, if emissions are either not applicable to offshore exploration or no data are available to estimate EFs.	Ole-Kenneth Nielsen	Accepted with modification	We now state in line 1790: “In the table below, several options for onshore exploration emission factors are presented.” and in line 1795: “Emission factors are available for both onshore unconventional and onshore conventional oil exploration; offshore emission factors for exploration are not included.” In the second column of Table 4.2.3 we also note that these are for onshore wells.
4568	2	4	2062	2063	Table 4.2.9 only deals with onshore exploration, and I found no mention of offshore exploration in the text. It would be good to include offshore exploration in the table either with default EFs or with NA/NE, if emissions are either not applicable to offshore exploration or no data are available to estimate EFs.	Ole-Kenneth Nielsen	Accepted with modification	We now state in line 1890: “In the table below, several options for onshore exploration emission factors are presented.” and in line 1896: “Emission factors are available for both onshore unconventional and onshore conventional oil exploration; offshore emission factors for exploration are not included.” In the second column of Table 4.2.9 we also note that these are for onshore wells.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
4570	2	4	2204	2205	The EFs for 'LNG: Import/Export' are they to be considered as loading/unloading EFs? It seems that would be the terminology usually used, e.g. in the chapter on emissions from transport/storage of crude oil. The size of LNG terminals vary significantly, and the EF for loading/unloading seems very high for some small terminals. It would be helpful with information on the average size of the terminals from which the default EFs have been derived.	Ole-Kenneth Nielsen	Accepted with modification	Yes, LNG Import/Export is synonymous with LNG loading/unloading, in a sense. Information on the size of the terminals used to quantify the EFs from the US GHGRP can be found here in Table 5: https://www.epa.gov/sites/production/files/2018-10/documents/ghgi_2018stakeholders_segment.pdf. This reference is included in the references. And footnote (e) of Table 4.2.4I.
4572	2	4	2248	2249	The use of the classification of gas losses as low, medium or high at selected types of natural gas facilities as a source for a default EF for appliance losses seems questionable. The source of the data is reported in the 2006 IPCC GL as "Adapted by the authors from currently unpublished work by the International Gas Union, and based on data for a dozen countries including Russia and Algeria.". This is hardly a solid reference as it is unpublished, not peer-reviewed and impossible for users to analyse and hence assess the applicability at a wider scale. Residential natural gas boilers are usually placed indoors and with odorant being added to the natural gas any leakages would be detected and repaired, which makes it unlikely that leaks of the magnitude suggested would occur. If including a default EF the scientific basis should be better than what is currently the case. The appropriateness of the EFs should be reassessed and if proper data are not available no default emission factor should be provided. The same concern applies to the EF suggested for large-scale users. The use of the value for 'rest of the world' from an obsolete version of the IPCC GL should not be considered sufficiently scientifically robust to form the basis of a default EF. To simply base default EFs on old unpublished studies from more than 20 years ago is bad scientific practice and it should not be accepted by the IPCC, if the credibility of the IPCC guidelines is to be preserved.	Ole-Kenneth Nielsen	Rejected	Meanwhile the IGU study was published - however, the values provided in the refinement compare to a recent Californian study (https://pubs.acs.org/doi/10.1021/acs.est.8b03217) and also match with the guidance of the German Technical and Scientific Association for Gas and Water (DVGW) that allows a maximum of 0 - 1 liter per hour during leak test. The Californian study was published after the literature cut-off date and cannot be used for the refinement. The values from the DVGW can be found in working sheet G600 but unfortunately, it is not cost-less available and not in English. Hence, it was not accepted as literature for the guidelines.
4574	2	4	2248	2249	It is not clear whether the EF for natural gas vehicles covers emissions from the whole chain, i.e. storage at filling stations, the refuelling of vehicles and emissions from vehicle tanks. This should be specified.	Ole-Kenneth Nielsen	Accepted	Clarification has been provided.
4586	2	4	3138	3139	Since the reporting requirements are to report emissions from venting, flaring and fugitive loses separately, this annex is very important. The authors should dedicate themselves to properly check this annex. While some errors have been corrected between the FOD and SOD, there are still very strange splits that if maintained at least should be explained. E.g. one would always expect CO2 and N2O to predominately stem from flaring, while CH4 usually will be dominated by leaks and venting. With that in mind the following splits seem to require further information: Offshore oil production (99 % of CO2 and N2O listed as coming from venting!), Oil sands mining (suddenly decimals on the split - does not in all cases sum to 100 %)	Ole-Kenneth Nielsen	Accepted	Rechecked annex and made edits.
4588	2	4	3141	3142	What types of leaks are considered that would account for 55 % of the CO2? Also data for NMVOC and N2O should be provided as there is a defualt emission factor included in the chapter.	Ole-Kenneth Nielsen	Accepted with modification	Correction made to leak % for CO2 (change from 45% to 55%). Calcination is the main process contributing CO2 emissions from leaks. Values for NMVOC and N2O added.
4590	2	4	3144	3145	Several instances, where the percentages does not sum to 100. I have the suspicion that the N2O shares have simply been taken from the CO2. It is difficult to envision how N2O would be released from leaks/vents in oil production. It would normally be assumed that N2O comes from flaring. This should be checked through all tables. That 99 % of CO2 and N2O from offshore production should be from vents seems incorrect, especially since no CH4 is presumeaably coming from vents. CH4 and NMVOC splits sum to 105 % for gas processing with LDAR. NMVOC and N2O for acid gas removal should be 100 % as default EFs are provided.	Ole-Kenneth Nielsen	Accepted	Throughout, I changed all N2O to 100% from flaring. Offshore has been updated. Typo in processing has been corrected. NMVOC and N2O for acid gas removal have been corrected.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
4592	2	4	3148	3149	Gas storage is missing from this table and should be included to match table 4.2.12 in the main chapter. Flaring is typically more common in connetion with gas storage whereas for gas transmission flaring is usually very small to non-existing. It would also be good if assumptions could be provided for LNG.	Ole-Kenneth Nielsen	Accepted	I added the splits for storage and for LNG to the annex.
4596	2	4	1349	1349	The chapter is updated to reflect town gas and biogas, but the chapter name is "…natural gas…". It should be decided if natural gas should be replaced throughout the chapter except at places where it refers only to natural gas.	Ole-Kenneth Nielsen	Rejected	During the IPCC Scoping Meeting, in which the terms of reference and the table of contents for the 2019 Refinement were drafted, this issue was discussed and it was decided to keep the original denomination in the 2006 IPCC guidelines.
4598	2	4	1395	1395	What does incineration refer to when it is not flaring and not incineration with energy production, which belongs in the stationary or mobile combustion sector?	Ole-Kenneth Nielsen	Accepted	We deleted "incineration" from the grayed out sentence.
4600	2	4	1443	1443	(e)Distribution refer to Fugitive emissions from natural gas appiances, but should be gas appliances to include e.g. town gas and biogas appliances.	Ole-Kenneth Nielsen	Accepted	Removed the word "natural" in the graphic.
4602	2	4	1557	1557	The first step in the diagram should be deleted ("Is there oil transport, upgrading, refining or product distribution in the contry"), as this is unnecessary and corresponding steps are not included in the other decision trees.	Ole-Kenneth Nielsen	Accepted	The decision tree has been updated with clearer text and to be consistent across segments.
4604	2	4	1575	1575	Non-key should be changed to not-significant cf. Figure 4.2.5 ("If emissions from abandoned wells are key category, are contributions from abandonned wells significant?" - "No" - "Estimate emissions using a Tier 1 approach")	Ole-Kenneth Nielsen	Accepted with modification	Decision tree is deleted. It is assumed that decision trees on main categories (oil and gas industries) cover subcategory on abandoned wells.
4606	2	4	1829	1829	Table 4.2.3 are missing EF for offshore exploration. All EFs refer to onshore wells	Ole-Kenneth Nielsen	Accepted with modification	We now state in line 1790: "In the table below, several options for onshore exploration emission factors are presented." and in line 1795: "Emission factors are available for both onshore unconventional and onshore conventional oil exploration; offshore emission factors are not included." In the second column of Table 4.2.3 we also note that these are for onshore wells.
4608	2	4	1862	1864	What is the reasoning behind the statement "If no data are available to estimate the share of onshore versus offshore production, EF for onshore production should be" applied to the total quantity of oil production."	Ole-Kenneth Nielsen	Rejected	This was done to provide a default approach in the case that a compiler lacks data on the split of production that occurs offshore versus onshore.
4610	2	4	1909	1909	The EFs for offshore oil production show a very large increase (more than a factor 1000) compared to the IPCC 2006 GL. Is this correct or could there be there be some unit error?	Ole-Kenneth Nielsen	Rejected	The 2019 EFs were developed from reported data from the Gulf of Mexico. It is not possible to do a detailed comparison with the 2006 GL factors as no reference is provided (e.g., we can't determine if offshore conditions are different between the two data sets, or if any unit error was made in the 2006 data set).
4612	2	4	1945	1945	According to the note to Table 4.2.6 ("…. The factors include fugitive equipment leaks, flaring, storage, handling, calcination and anode production.") the EFs include emissions from flaring, but these emissions should be reported under 1B2c. Including flaring in the emission factor for oil refining can cause double counting of emissions for Parties wstimating emissins from flaring using higher Tier methods. Including the disaggregated EFs from Annex 4A.2 in the EF table could solve this issue	Ole-Kenneth Nielsen	Rejected	Emissions from flaring have to be integrated into the appropriate segment (1 B 2 a and b). Not 1 B 2 c.
4614	2	4	1948	1948	Flaring should not be included in 1B2av as stated in the text, but in 1B2c	Ole-Kenneth Nielsen	Accepted with modification	See comment No. 7544; basically no flaring activities in distributions of oil products.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
4616	2	4	1965	1965	EFs in Table 4.2.7 refer to unabated distribution. Guidelines for distribution with abatement is missing. Further the note to the table states that emissions are temperature dependent, but guidelines for this is missing.	Ole-Kenneth Nielsen	Accepted with modification	We added a sentence in the footnote of table 4.2.7: "Several techniques like vapour-balancing and vapour-recovery along with use of automatic monitoring systems will have a significant influence of the factor, in which case country-specific Efs should be developed to reflect reduction efficiency and level of applicaiton of such techniques." Insufficient data are available to provide default EFs for abatement, or further guidance on temperature impacts.
4618	2	4	2022	2022	The text states that this segment (exploration) includes flaring, which should be reported in 1B2c	Ole-Kenneth Nielsen	Accepted with modification	“This segment includes fugitive emissions (equipment leaks, venting and flaring) …”. Flaring is part of 1 B 2 a and b. Not 1 B 2 c.
4620	2	4	2062	2063	Table 4.2.9 is missing EFs for offshore gas extraction.	Ole-Kenneth Nielsen	Accepted with modification	We now state in line 1890: “In the table below, several options for onshore exploration emission factors are presented.” and in line 1896: “Emission factors are available for both onshore unconventional and onshore conventional oil exploration; offshore emission factors for exploration are not included.” In the second column of Table 4.2.9 we also note that these are for onshore wells.
4622	2	4	2065	2065	The text statates that this segment (exploration) includes flaring, which should be reported in 1B2c	Ole-Kenneth Nielsen	Rejected	We're recommending that flaring be included in the segments where it occurs.
4624	2	4	2076	2078	The guidelines should include uniqe tier 1 methodology and corresponding set of EFs. Now the guidebook provides two sets of EFs based on different AD, and leave it up to the inventory compilers to assess which EFs reflect the countrys emissions . No guidance is provided for this assessment, and it is not clear what the parties should report if information are not available to make the necessary assessment of the calculaed emissions. The Tier 1 methodololy should include only oen set of EFs per source.	Ole-Kenneth Nielsen	Rejected	Previously, the guidelines disaggregated emissions from “developing” and “developed” countries, leaving it to the inventory compiler to decide which category was appropriate. However, the 2019 Refinement acknowledges that the true discriminant should be technology/practice based, as this is the more important determinant of emissions since the oil and gas industry can be quite sophisticated, even in developing countries. The guidelines do suggest to the inventory compiler the best practices for selecting EFs based on available activity data and known technologies or practices used in country.
4626	2	4	2098	2099	What is the reasoning behind the statement "If no data are available to estimate the share of onshore versus offshore production, EF for onshore production should be" applied to the total quantity of oil production."	Ole-Kenneth Nielsen	Noted	This was done to provide a default approach in the case that a compiler lacks data on the split of production that occurs offshore versus onshore.
4628	2	4	2100	2102	Venting and flaring shall be reported in 1B2c. This induce parties to either make double counting of emissions from flaring or underestimate (leave out) emissions from production as guidance including EFs are not included in the 2019 refinement. Including the disaggregated EFs from Annex 4A.2 in the EF table could solve this issue	Ole-Kenneth Nielsen	Rejected	The BOX 4A.2.1 already guides users how to developed disaggregated Efs by using overall EF and disaggregated fraction.
4630	2	4	2102	2102	"disaggregated Tier 1 EF are available in Annex 4A.2". Why are these not included in the main chapter? At least the EFs should be disaggregated to the level of the CRF tables.	Ole-Kenneth Nielsen	Rejected	Adding the disaggregation option to the main body unreasonably lengthens the text. Further, in the updates, emissions are reported in the segment where they occur.
4632	2	4	2116	2116	It is noticed that the EFs for offshore gas production has increase compared to the IPCC 2006 GL, and has exceeded the upper limit.	Ole-Kenneth Nielsen	Noted	The 2019 EFs are developed from a large data set from the Gulf of Mexico. It is not possible to do a detailed comparison with the 2006 GL factors as no reference is provided (e.g., we can't determine if offshore conditions are different between the two data sets, or if any unit error was made in the 2006 data set).
4634	2	4	2146	2146	In Denmark, town gas is a mixture of natural gas and ambient air (mix ~ 51/49) sinec 2007. before that town gas was based on oil and even earlier on coal.	Ole-Kenneth Nielsen	Rejected	The guidelines provide a default if no national data is available -if this differs in a country it is good practice to develop an country specific EF

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
4636	2	4	2192	2193	Disaggregated EFs for storage is not included in Annex 4A.2, so parties that have country specific calculations of fugitive emissions from transmission are missing guidance for estimating emissions form storage.	Ole-Kenneth Nielsen	Accepted with modification	Disaggregated EFs for gas storage have been provided in Annex.
4638	2	4	2248	2248	EFs for towngas are only applicable for the town gas type described in l. 2146. In denmark the EFs will be 51% of EF for natural gas.	Ole-Kenneth Nielsen	Rejected	The GL provide a default - if national circumstances differ it is good practice to use CS EF and a higher tier.
7438	2	4	2146	2152	in first two sentences, town gas production is refered to hydrogen chapter. In following sentences it is refered to table 4.2.11 - I guess sour gas is meant in the text.	Jens Reichel	Accepted	Changed
7440	2	4	2153	2157	processing of town gas is not part of the chapter - please correct equation	Jens Reichel	Accepted	Changed
7442	2	4	2206	2249	End-Use emissions should not be aggregated with emissions from operations of natural gas systems. To improve transparency, those emissions should be reported in a seperate subcategory.	Jens Reichel	Accepted	Changed
7448	2	4	1931	1931	asphalt blowing has been part of the industry chapter 2.D.3.g in previous GL - please delete here	Jens Reichel	Rejected	The IPPU section 5.4.1 is explicit that asphalt production in refineries is excluded from the scope of reporting in IPPU, whilst the new Energy - fugitives section 4.2.2.3 for 1B2aiv also explicitly states that emissions from asphalt blowing in refineries are included there. The authors consider that this is clear, unambiguous guidance on best practice for reporting of emissions from asphalt production.
7456	2	4	2235	2235	there is no disaggregated emission factors by pipeline material available in Annex 4.A.2.	Jens Reichel	Accepted with modification	The reference has been deleted. To see the disaggregated emission factors go the the German NIR 2017 in chapter 3.3.2.2.5.1.
7460	2	4	1951	1951	take " Vol 3 chapter 3 " instead of CRF code	Jens Reichel	Accepted	Changed
7464	2	4	1925	1925	Pipelines: If a transport pipeline runs through three countries and none of them takes even a drop of the oil transported, all countries report the same emission when using the emission factor provided. In this case the emission reported would be three times higher then if the same pipline is located in one country. I see a problem for the EU to have to report very high emission. Is is possible to provide a factor in tons per kilometer pipeline?	Jens Reichel	Rejected	The EF provided was adopted from the 2006 GL . To avoid an overestimation it is recommended to use a higher tier.
7544	2	4	1787	2265	In description of most subcategories of oil (i.e. 1 B 2 a i Exploration, 1 B 2 a ii Production and Upgrading, 1 B 2 a iii Transport, 1 B 2 a iv Refining, 1 B 2 a v Distribution of Oil Products, 1 B 2 a vi Other) and gas systems (1 B 2 b i Exploration, 1 B 2 b ii Production and Gathering, 1 B 2 b iii Processing, 1 B 2 b iv Transmission and Storage, 1 B 2 b v Distribution, 1 B 2 b vi Other) it is written that segment includes fugitive emissions, including leaks, venting and flaring (e.g. Line 1833). In the last guidelines was written that emissions excluding venting and flaring. We are not sure that venting and flaring in fact occur in all subcategories of oil and gas systems. And for instance, in description of subcategory 1 B 2 a iii Transport, it is not further mentioned if the default emission factors are inclusive of venting, flaring and leaks or not, which could cause misunderstanding. This same issue is in other subcategories as well.	Eva Krtkova	Accepted	Line 1912: leaks and venting (oil transport); Line 1948: leaks and venting (distribution of oil products); Line 2207: leaks, venting and any flaring (gas distribution); Disaggregation for oil and gas exploration and gas storage and LNG added to the annex.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
7822	2	4	1443	1444	It is unclear what "Offshore Gas Liquefaction" (LNG) means in the figure. Most liquefaction plants are included onshore. Further, LNG liquefaction occurs after Transmisson. Similarly on the destination point, the regasification terminal receives the LNG and then the natural gas into the transmission systems. Recommend that IPCC revise the supply chain framework with consultation with industry.	FIJI GEORGE	Accepted with modification	LNG is only mentioned in 1B 2b iv in the text, so we remove any wording about it under the Processing column. We alter the wording under Transmission and Storage to read “LNG Stations and Export/Import Terminals (Liquefaction, Re-gasification), Transport & Storage.” We connect this with a green arrow to the LNG truck and ship to represent transportation. Under the onshore plant next to the underground storage we now state: “LNG Stations and Export/Import terminals (Liquefaction, Re-gasification), transport, and storage”. The boat next to it has the listing LNG transport (and obviously represents shipping). In the caption for the figure we now note: “Note: this diagram provides examples of activities included in the segments of oil systems; it is not intended as a flow chart or supply chain diagram.” It is out of scope to “revise the supply chain framework with consultation with industry.”
7824	2	4	1443	1444	Fugitive emissions from natural gas appliances (e.g. internal pipes and applicances like stoves, dryers, heaters, grills) are illustrated in Figure 4.2.1. Emissions from end-use should be listed separately under "additional" or within each specific end-use sector (residential/commercial OR power OR industrial) with a clear listing that these are methane emissions.	FIJI GEORGE	Accepted with modification	These emissions are in scope of natural gas systems, and were moved from Distribution systems to a new group, "Post-meter emissions."
7826	2	4	1546	1547	Figure 4.2.2 is applicable for natural gas systems, but as cited in the comments above, LNG systems has a different pathway and profile.	FIJI GEORGE	Accepted with modification	We have modified the figure to add additional features of the LNG profile. See response to comment #7822.
7828	2	4	1613	1614	Table 4.2.1: LNG systems should not be "lumped" with Gas Transmission. The International Energy Agency (IEA) World Energy Outlook 2017 (WEO) projects the global demand for natural gas will see a compounded average annual growth rate of 0.6-1.9% in the timeframe of 2016-2040, with LNG provided a significant portion of this growth. It is technically and functionally incorrect to mix LNG liquefaction and regasificaiton facilities with Gas transmission systems. Completely different processes. Recommend IPCC develop a separate industry segment in light of future projections on LNG demand with industry before the 2019 Refinements are finalized.	FIJI GEORGE	Noted	It is out of scope to develop an additional segment at this time. Of importance to the guidelines is that all fugitive emissions be captured. Within the framework of the 2019 Refinement, we retain LNG (i.e. its liquefaction, regasification, and transmission) as part of Natural Gas Systems category 1 B 2b iv as described in the text.
7830	2	4	1615	1721	Consider application of the latest reserch from Stanford (Separately consider the CO2 aspects in the other chapter)- Masnadi et al. for Tier 2 factors.	FIJI GEORGE	Noted	No action can be taken because comment is out of scope of 2019 Refinement. 1) The reference is more about GHG projection, not GHG estimation for a particular year; 2) The age distribution of the oil wells is not avaiable in many countries. 3) The mandate is to develop Tier 1 Efs.
7832	2	4	1980	2019	It appears that the IPCC is relying on a very small subset and based in US and UK to develop the emission factors. The IPCC should first consider are these material emissions and review the methods by Kang et al and Townsend-Small as being representative. With huge uncertainty ranges included in Table 4.2.8, is it worth to incorporate this source category into the the 2019 refinement?	FIJI GEORGE	Rejected	A number of data sources were reviewed for abandoned wells, each confirming that abandoned wells is a sizable emissions source. The studies also found similar rates of emissions for abandoned wells. The EFs presented come from a large number of measurements and are appropriate tier 1 factors.
7834	2	4	2082	2086	It is incorrect to state that liquids unloadings with plunger lifts is a lower emitting technology than manual unloadings. There are multiple factors that go into unloadings and while on a unit-basis, plunger lifts may have lower emissions, it is not necessarily true on a total cummulative basis. Further, plunger lifts are merely ONE form of artificial lifts. Gas lifts and other techniques also serve the same purpose. Finally, failure of plungers and other artificial techniqes cause these sources to behave like manual unloadings. Please see Schwietzke et al (2016), where over 50 unloadings were classifed as manual, when in fact many were due to failures of the artificial lift system which caused these wells to behave like manual unloadings.	FIJI GEORGE	Accepted with modification	Edited text.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
7836	2	4	2116	2117	Table 4.2.10: Footnotes a and b cite the 1996 GRI study. The National Academies of Sciences in the US have reviewed this extensively and called out many improvements to emission factors. As one of the authors of that study, I urge the IPCC to reconsider the use of outdated factors. Table 4.2.10, footnote d references emission factors previously developed for gas storage facilities. The Department of Energy has commissioned a study that will provide methane emission factors specific to gathering and boosting stations for use in greenhouse gas inventories. The study will also review episodic events.	FIJI GEORGE	Rejected	GRI factors are used primarily for early years 1990's of US time series, and we think represent practices then, and practice without mitigation. For recent years, better data can be used to caculate emisisons and we've done that and it's in the EFs presented here in many cases. Footnote d refers to Marchese, which measured gathering stations specifically, and to GRI for blowdown emissions (data unavailable specific to gathering). The DOE study mentioned here is not available yet.
7838	2	4	2116	2117	Footnote d for Gathering refers to Marchese et al. Please refer to recent studies by Vaughn et al (2017) published in Journal Elementa (gathering and boosting stations. Elem Sci Anth. 2017;5:71. DOI: http://doi.org/10.1525/elementa.257) and Vaughn et al (2018- approved for publication in PNAS). There are other studies in the works funded by the US Department of Energy that will be soon released. These two independent studies are being conducted by Colorado State University (Dan Zimmerle) and GSI Environmental Inc. (Ann Smith-PI - https://www.netl.doe.gov/research/oil-and-gas/project-summaries/natural-gas-midstream-projects/fe0029085-gsi and https://www.netl.doe.gov/research/oil-and-gas/project-summaries/natural-gas-midstream-projects/fe0029084-gsi). These will provide a significantly larger data set and avoid the limited data from the Marchese et al study.	FIJI GEORGE	Rejected	The footnote refers to references used in the EFs presented in the table. The studies noted in the comment were not used in the EFs. The Vaughn study showed higher emissions than the Marchese study, while other studies showed lower emissions (Yacovitch et al 2017 and US EPA GHGRP data). The DOE studies have not been published yet and therefore cannot be considered.
7840	2	4	2064	2109	The application of LDAR voluntarily or regulatory is now a growing practice in the US and elsewhere. The efficacy of LDAR has been illustrated in many regulatory programs and papers (Ravikumar, A. et al (2017, 2018), George, F. (2018- World Gas Conference- See Tables S1-S4)	FIJI GEORGE	Accepted	Included in description of lower emitting technologies.
7842	2	4	2126	2130	"Where this information is unknown, or where there are limited or no LDAR programs, the “without LDAR, less than 50% of centrifugal compressors are dry seal” emission factors for Gas Processing should be used. What is the basis of this information? It would be more appropriate to go with the vintage of the compressors. Dry seals are now standard for most aero-deravative compressors.	FIJI GEORGE	Rejected	We don't have information on vintage of compressors. I think it's okay that dry seals are now standard. The wet seal EF can be used for years when it's not standard.
7844	2	4	2158	2159	Table 4.2.11. Contrary to National Academies of Sciences' advise, the SOD once again recommends using outdated emission factors from the 1996 GRI study. There are multiple new studies that are out there and highly recommend IPCC consider them. Also as noted above, the basis of using LDAR as proxy for dry and wet-seals seems to be without merit. At a minimum, the basis for this guesstimate should be provided. In my about 25 years with the industry, I have not seen or understand this.	FIJI GEORGE	Accepted with modification	1) Agree that there are new studies on which the factors for low-emitting technologies are based. However, the higher emitting practices/technologies which are still used widerly are still best represented by the 1996 report. 2) The relationship between LDAR and dry-wet seals has been further clarified in both text and table 4.2.11.
7846	2	4	2170	2172	LNG import and export terminals should NOT be included in the Transmission and Storage sector. Rather as noted on Row 13 and 16 of these comments, they should be separate source category. Also see MARCOGAZ 2018 (SURVEY METHANE EMISSIONS FOR LNG TERMINALS IN EUROPE). And also see GHGRP for emissions from Cheniere's Sabine Pass Liquefaction terminal and other US operators (see excel spreadsheet)	FIJI GEORGE	Rejected	Import/export terminals are part of Transmission and Storage per 2006 guidelines. It is out of scope to take LNG Import/Export terminal emissions out of 1B 2 b iv.
7848	2	4	2205	2205	Table 4.2.12: What is the basis for emission factors with and without higher emitting technologies or practices. Neither the GHGRP or Zimmerle (2016) provides the granularity to assess the efficacy of LDAR. There are multiple papers that will be out soon. And the assumption of 40, 60 and 80% reductions by LDAR is a incorrect (See incorrect basis and errors in the assumptions - see George et al 2018 (World Gas Conference))	FIJI GEORGE	Accepted with modification	Added text to clarify where the factors are from. we're not using an assumption of 40/60/80, we're just using more recent years of data, when LDAR is used, to show lower emitting technologies, and older data to show higher emitting technologies.
7850	2	4	2432	2456	The National Academies provides advise on issues with time-series look-backs. Highly recommend IPCC committee to review recommendations of the US National Academies of Sciences	FIJI GEORGE	Rejected	Out of scope of Energy volume.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
7852	2	4	1530	1530	Variability of methane emissions measurements and over time is addressed in multiple studies especially Vaughn et al (PNAS, 2018). The influence of episodic events (unloadings, flowbacks and maintenance) versus malfunctions versus routine operations should be clearly understood. In fact, Tier 3 level estimation should incorporate these recommendations (see NAS recommendations) to develop a better estimate of emissions. The role of super emitters should NOT be incorrectly attributed based on a skewed statistical model. Additionally for compressor sites in a study completed for the DOE by GSI Environmental Inc.. The TFI team should review these studies to address the variability concerns.	FIJI GEORGE	Rejected	Tier 3 is out of scope. Furthemore, DOE/GSI studies are not yet published and therefore cannot be considered.
7854	2	4	1613	1614	Should marginal (or low producing) gas and oil wells be included on Table 4.2.1? There have been conflicting studies that assess the impacts of marginal wells. Regardless the TFI may want to consider disaggregating marginal wells and non-marginal wells and develop appropriate emission factors in (kg/MCF or cu.m).	FIJI GEORGE	Rejected	As the commenter notes, there are conflicting studies on marginal wells. The estimates would likely become much more uncertain by disaggregating EFs and also disaggregating activity data (most countries will not have data to split wells between marginal and non-marginal).
7856	2	4	2204	2205	Table 4.2.12, footnote d references emission factors previously developed for gas storage facilities. The Department of Energy has commissioned two studies that will provide methane emission factors specific to different types of gas storage wells to support development of more accurate facility-wide values using well counts and account for continuous capture of diurnal to seasonal variability of emissions from entire facilities with component-level resolution (e.g. specific compressor, sealed well head, etc. emissions rates).	FIJI GEORGE	Rejected	The DOE study is not published yet and cannot be assessed for this work.
7858	2	4	2385	2386	The statement "consistent terminology and clear definitions is critical in developing counts of facilities and equipment components" underscores the need for such terminology and definitions to be standardized. The Final Report for a current study being performed for the DOE by GSI Environmental Inc. provides a good example of objective guidelines for component counting and classification.	FIJI GEORGE	Noted	Referenced document is not published by required date
7860	2	4	2459	2460	The TFI is requested to review the recommendations of the National Academies. Further, the DOE has funded a study evaluating uncertainty associated with several accepted methane measurement technologies is in the process of being developed .	FIJI GEORGE	Accepted	The DOE studies have not yet been published so they cannot be considered. To address the NAS recommendation portion of the comment, we added "including whether the measurements capture any high-emitting subpopulations (e.g., malfunctions) and episodic sources and whether these have been incorporated into the average factors in a way that does not over- or under-estimate total emissions" to the emission factor uncertainty section. The NAS recommendations aren't really relevant to Tier 1 approaches, so not clear that a lot of it is in scope. Other NAS recommendations on uncertainty (e.g. importance of activity data) are already captured.
8358	2	4	1365	1366	Fugitive emissions from appliances should not be included as part of emissions from oil and natural gas systems	Miriam Levon	Rejected	Clarification added to the text that emissions occuring between gasmeters and appliances are covered by 1.B.2.b.vi while emissions from the appliances themselve (start-stop losses plus combustion) are not covered by the methodology.
8360	2	4	1443	1445	In Figure 4.2.1: Fugitive emissions from natural gas appliances (e.g. internal pipes and applicances like stoves, dryers, heaters, grills), should be removed from the depiction of emissions from natural gas systems. These emissions are attributable to the use of natural gas in residential or commercial settings.	Miriam Levon	Rejected	These emissions are in scope of natural gas systems, and were moved from Distribution systems to a new group, "Post-meter emissions."

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
8362	2	4	1790	1829	The table cited (Table 4.2.3) does not provide emission factors for offshore oil exploration. If the intent is for the emission factors to be used for both onshore and offshore exploraion, the text and the table should clearly note that.	Miriam Levon	Accepted	We now state in line 1790: “In the table below, several options for onshore exploration emission factors are presented.” and in line 1795: “Emission factors are available for both onshore unconventional and onshore conventional oil exploration; offshore emission factors for exploration are not included.” In the second column of Table 4.2.3 we also note that these are for onshore wells.
8364	2	4	1829	1830	Footnote (a) stipulates that, "factor is an average of 2003-2007 calculated implied emission factors for emissions from well drilling, well testing, and from well completions with hydraulic fracturing that do not flare or use gas capture". It is not clear why the factors provided are based on an average of 2003-2007 calendar years data.	Miriam Levon	Accepted	Added "The time period of 2003-2007 was selected as it represents a time when hydraulic fracturing is occurring, but before state or federal regulations were in place to control gas emis-sions. "
8366	2	4	1861	1864	Need to clarify whether emission calculations for oil production from oil sands should use the EFs for 'Oil Sands Mining and Ore Processing' or 'Oil Sand Upgrading' in addition to - or in lieu of - the other EFs provided for oil production.	Miriam Levon	Rejected	It has clearly mentioned that "production of oil sands is treated separately".
8368	2	4	1999	2000	The EF provided for abandoned wells have very high uncertainty bounds making it questionable why this emission source should be accounted for here. The information on which these EFs are based is sparse and limited in scope and its inclusion in GHG inventories should be deferred until more robust data is available	Miriam Levon	Rejected	Following Report of IPCC Scoping Meeting for a Methodology Report(s) to refine the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the category was considered for inclusion in the Guidelines. We disagree that available data is sparse and limited in scope. A number of studies of abandoned wells in the U.S., U.K. and the North Sea were reviewed, and showed comparable average emission factors. The Townsend Small et al study was selected to develop the EFs for onshore wells as it allowed for emission factors distinguished by plugged and unplugged status.
8370	2	4	2006	2007	The citation provided in footnote (b) of Table 4.2.8 references Vielstädte et al. (2015). That study indicates that "direct methane transport into the atmosphere was found to be negligible (<2%) due to the small bubble sizes and the water depth at which they are released." This is NOT consistent with the text that specifies that 80% of the methane emitted from offshore abandoned wells is dissolved in marine water.	Miriam Levon	Accepted	This is a misprint. 80% is replaced with 98%. The calculations of EFs are correct and consistent with the relevant text.
8372	2	4	2050	2053	The text and the referenced table (Table 4.2.9) do not provide a distinction between onshore and offshore natural gas exploration. If the intent is that the same Efs are applicable for onshore and offshore exploration than the text should clarify this to the users.	Miriam Levon	Accepted	Edited text to say: Offshore exploration emissions data are unavailable, and these emissions are thought to be negligible; there-fore, emission factors are not included for offshore exploration.
8374	2	4	2116	2117	The emission factors for gathering in Table 4.2.10 are based on outdated data which tend to underestimate emissions from this segment. The entries should be amended to reflect the latest data available directly from the U.S. GHGRP. It is important to emphasize emissions from compressor engines which a significant source for gathering and boosting operations. Also, in footnote (d) the use of data from Marchese et. al. 2015 is not applicable for global Tier 1 EFs for gathering. Marchese data is hardly representative of U.S. gathering operations and should not be extrapolated globally.	Miriam Levon	Rejected	1) The contribution of compressor engines has been mentioned in line 2071; 2) In order not underestimate emission by using Tier 1 EFs, the Marchese study was used instead of GHGRP data whoes emission rates LOWER than the Marchese sutdy. So if Marchese underestimates, using GHGRP would make the issue worse. 3) The combination of the old data and new data could reflect the real situation better than one set of data.
8376	2	4	2147	2158	Town gas processing is discussed in the text and Eq.4.2.15 requires the use of the corresponding EF, if such processing is practiced in the country. However, the EF for town gas processing is not provided in Table 4.2.11. Please amend.	Miriam Levon	Accepted with modification	Production of town gas should be reported under fuel transformation - the equation has been corrected.
8378	2	4	2224	2225	Fugitive emissions from appliances and power plant (post meter) should not be included as part of Distribution segment fugitive emissions.	Miriam Levon	Accepted	Changed.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
8380	2	4	2230	2235	Emissions from appliances and power plants - including leakage after gas meters - should be reported as fugitive emissions from the respective sectors, i.e. residential, commercial and power generation and not included here with the Distribution segment emissions.	Miriam Levon	Accepted	A new segment has been added for those emissions.
8382	2	4	2248	2249	In Table 4.2.13 the Distribution segment EFs for 'Natural gas-fueled vehicles', 'Appliances in commercial and residential sector', and 'Leakage at industrial plants and power stations' should NOT be included here. They should be included in the applicable chapters that include guidance for transportation, commercial, residential, industrial and power generation.	Miriam Levon	Accepted with modification	A new segment has been added for those emissions.
8384	2	4	2260	2265	The lack of data indicated here is a clear manifestation that it is premature to include emission estimates from abnadoned oil and gas wells in national inventories untill more data becomes available.	Miriam Levon	Rejected	Following Report of IPCC Scoping Meeting for a Methodology Report(s) to refine the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the category was considered for inclusion in the Guidelines. We disagree that available data is sparse and limited in scope. A number of studies of abandoned wells in the U.S., U.K. and the North Sea were reviewed, and showed comparable average emission factors. The Townsend Small et al study was selected to develop the EFs for onshore wells as it allowed for emission factors distinguished by plugged and unplugged status.
8386	2	4	3919	3919	In the references to Section 4.2 add the specific references to: (1) API GHG Methodology Compendium (2009), (2) IPIECA/API GHG Reporting Guidleines (2011), and (3) API LNG GHG Methodology (2015). These three citations are provided in the text but not included in the References list here.	Miriam Levon	Accepted	References added.
8452	2	4	1778	1784	Tier 1 methane emission factors for Oil and Natural Gas Systems (O&G) are based primarily on data from the United States Environmental Protection Agency Greenhouse Gas Inventory (US GHGI). Alvarez et al 2018 (paper and supplementary material attached as Vol2_Ch4_1778_1784_172 and Vol2_Ch4_1778_1784_174) report that 2015 U.S. O&G methane emissions based on ground-based measurements from 6 regions and validated with aircraft observations from 9 regions are ~60% higher than US GHGI estimates. This disrepancy is attributed to the US GHGI excluding emissions from abnormal or otherwise avoidable conditions that are difficult to quantify with equipment-based measurement approaches traditionally used to develop inventories. Therefore, Tier 1 emission factors likely are biased low and their application will tend to underestimate emissions (assuming factors only are used for sources with emission profiles similar to the United States). As discussed in Volume 1 Chapter 6, atmospheric measurements should be used to improve the accuracy of inventories including the US GHGI and related data such as the Tier 1 emission factors. To highlight this important point, I recommend citing Alvarez et al 2018 in Volume 2 and adding the following sentence to the end of the referenced paragraph. "The accuracy of factors is dependent on the uncertainty of underlying data and it is good practice to verify and update factors as new data become available".	David Lyon	Accepted with modification	The suggested language was edited so that it is addressing inventory compilers, and added to the text. "In addition, the accuracy of factors is dependent on the uncertainty of underlying data. A country should periodically assess changes in technologies and practices, and changes in available emissions data, and consider updating estimates using at least a Tier 2 approach, per good practice."
8456	2	4	1387	1389	Could you specify or examine more details about "country's circumstance" effecting on the fugitive emissions?	Pornphimol Winyuchakrit	Accepted	Edited to say "will vary according to the amount of oil and gas produced, consumed, imported and exported, and according to technolgies and practices in place in different segments that may increase or decrease emissions"
8716	2	4	1434	1438	Suggestion for a tiny modification. In the exploration and production elements of the charts (lower part) one could add a little flare on each of the towers as these are alwys there in real life (or maybe they are there but very small?) o.	Zbigniew Klimont	Accepted	Added.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
8718	2	4	1830	1830	I wonder if the recently publised data in the Science paper on the US underestimation of methane from US oil and gas systems has been considered. I see in the text the ref to EPA only.	Zbigniew Klimont	Accepted with modification	Addressed this through comment 8452 on the Alvarez study (adding the sentence).
8720	2	4	1830	1830	Table 4.2.3. The comment as above but another study from last year looking at loses of methane from oil production	Zbigniew Klimont	Accepted	See comment NO. 8452 (and 8718), a new sentence has been added to reflect the progress of new studies.
8860	2	4	2204		Table 4.2.12 Shows Uncertainty levels for fugitive emissions in gas transmission, storage and distribution to be -20-500%. Are there any efforts to provide leakage rates per country? Considering types of pipelines, age, etc?	MINGMING WANG	Rejected	Identification of Tier 2 EFs (country-specific one) is out of the scope.
9002	2	4	1463	1464	Casing-head gas venting may also occur at stripper wells. Suggest changing the subject text as follows" …. heavy oil wells and stripper wells where…..".	Picard Dave	Noted	No action can be taken because comment is out of scope of 2019 Refinement.
700	2	4	2587	2588	It is proposed that in this paragraph, the authors provide the description of fuel transformation process and identify the greenhouse gasses released during this process.	Mikhail Gitarskiy	Accepted with modification	A definition of fuel transformation has been added under Heading 4.3. The specific GHGs that are released in each transformation are discussed in the respective sections.
3416	2	4	2594	2596	"Fugitive emissions from the following fuel transformation activities have been included in this section - charcoal production, coke production, other solid fuels to solid fuels, coal to liquid, gas to liquid, biomass to liquid, biomass to gas, and refineries." I can see no other references to refineries in section 4.3. Are refineries actually included here?	Håkon F. Skullerud	Accepted	This Chapter does not cover this source. Cross reference has been added "refineries are considered in Chapter 4.2 in this volume."
3962	2	4	2598		Table 4.3.1, fourth column, please add references	Andrea TILCHE	Accepted with modification	Column has been removed to simplify the table.
6142	2	4	2598	2599	I suggest that the authors replace "[add reference]" by "Chapters 1 and 2 of this Volume" under the fourth column of Table 4.3.1.	Naofumi Kosaka	Accepted with modification	Column has been removed to simplify the table.
2904	2	4	2607	2608	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted	Biblographical citation format done.
2906	2	4	2611	2611	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted with modification	The sentence includes the references has been deleted in the FD.
1960	2	4	2626	2626	An error was found in the Figure 4.3.1. For countries where charcoal production is a key category, the arrow should start from the rhombus, not from the rectangle.	DONGKOO KIM	Accepted	An arrow has been inserted from rhombus instead of the rectangular.
702	2	4	2626	2627	The decision tree in Figure 4.3.1 is inconsistent with the concept of inventory preparation and improvement, which builds upon key category analysis, as outlined in Volume 1 ofthe 2006 Guidelines. In the 2006 Guidelines, the question if the category concerned is key stands in the beginning of the decision tree and guides further actions by the inventory compilers. To maintain concictency with general guidance in Volume 1 of the 2006 Guidelines, it is proposed that the authors reconcile the oder of questions in the decision tree to move the key category identification on top of it.	Mikhail Gitarskiy	Accepted	The question on key category is at the end in practically almost all decision trees in the energy volume. Therefore this decision tree is in line with almost all decision trees in volume 2.
1992	2	4	2626	2627	In Figure 4.3.1 Decision tree for charcoal production, the word “Yes” on the arrow line between Diamonds box “Is national charcoal production data available?” and Diamond box “Is charcoal production a key category?”, should be changed to “No”.	DAN YU TIAN	Accepted	"NO" has been inserted down from "Is national charcoal data available" and an arrow has been inserted from rhombus instead of the rectangular.
1994	2	4	2626	2627	The arrow line approaching Square box “Collect data for higher Tiers” should originate from Diamond box “Is charcoal production a key category?”, instead of from Square box “Tier 1. Estimate emissions using fuel data and default emission factors”.	DAN YU TIAN	Accepted	The arrow for "collecting data from for higher tiers" has been changed to to originate from Diamond box specifying is "charcoal produced a key category".

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
4576	2	4	2626	2627	Figure 4.3.1 needs some help. Both ways out of 'Is national charcoal production data available' are 'Yes'. Also, apparently, the only answer to the question 'Is charcoal production a key category' is no. While this may be accurate, there probably should be a Yes route as well.	Ole-Kenneth Nielsen	Accepted	The arrow for "collecting data from for higher tiers" has been changed to to originate from Diamond box specifying is "charcoal produced a key category".
3964	2	4	2636	2639	The equal signs in the explanation for the equation need to be lined up- editors should do this.	Andrea TILCHE	Accepted	
4578	2	4	2647	2649	The default EFs is not depending on kiln type and therefore the title of the table should be changed. The same change should be applied to the EF description in line 2638.	Ole-Kenneth Nielsen	Accepted	Text deleted.
7444	2	4	2648	2649	the chapter describes that charcoal is produced from biomass but in fact, it is quite common to add compressed lignite briquetts to charcoal - please make clear that in that case, CO2 emissions should not be reported as memo item - please also provide a reference where to report emissions from charcoal use (e.g. 2.G.4)	Jens Reichel	Accepted	In some cases, charcoal is produced as biomass in the form of compressed lignite as reporteed by Yaman, et al, and Chaiklangmuang, et, al but there are no emission factors provided.
2908	2	4	2648	2649	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted	
7454	2	4	2649	2658	the FAO provides estimation of charcoal production of each country - would be helpful to mention this here	Jens Reichel	Accepted	Reference added for http://www.fao.org/faostat/
3966	2	4	2666		Table 4.3.3 seems not to be referred to in the text.	Andrea TILCHE	Accepted	Table 4.3.3 has been refereed in the text.
4580	2	4	2666	2667	The uncertainties information should be simplified to reflect that default EFs are not available by kiln type.	Ole-Kenneth Nielsen	Accepted	A sentence "it is noted that uncertainty range of information is irrespective of the type of kiln" has been added to the Table.
8722	2	4	2667	2815	The whole section about Coke has no reference to China, by far the biggest coke producer now and in the recent decades. The suggestion for emission facors based on German study and JRC review might be inapropriate for China; although I admit I have not checked and tried to make an essessment of plausability of this statemtn. I suggest the authors consider this and maybe analyze a study about transformation in Chinese coke sector; see ref to the Energy Policy paper	Zbigniew Klimont	Noted	The paper is: China's coke industry: Recent policies, technology shift, and implication for energy and the environment. Hong Huo et al, (2012). Energy Policy 51 (2012) 397–404. The chapter authors have reviewed the paper and the paper does not provide emission factors for the direct GHGs for fugitive emissions.
6144	2	4	2671	2671	I suggest that the authors add the following text at the end of line 2671: "Please refer to section 4.2, Volume 3 for the process emissions from metallurgical coke production."	Naofumi Kosaka	Accepted	Cross reference added to the section of the guidelines covering process emissions.
1388	2	4	2675	2675	Edit "… 1150 - 1350 oC, indirectly…"	Robert Lanza	Accepted	Text updated.
1390	2	4	2676	2676	Edit "…reducing agent used in hot metal production…"	Robert Lanza	Accepted	Text updated.
1392	2	4	2679	2679	Edit "… in the stock column of the blast furnace."	Robert Lanza	Accepted	Text updated.
1394	2	4	2680	2681	According to IEA data (see IEA Coal Information Overview, Table 1) coking coal production was 1 108.7 Mt (2014); 1 081.1 Mt (2015), and 1 074.3 Mt (2016)	Robert Lanza	Accepted with modification	Global coke production for 2016 added.
1396	2	4	2680	2681	According to EIA data (see EIA Metallurgical Coke Production, World Table) Metallurgical Coke production was 750,000 short tons in 2015	Robert Lanza	Accepted	The numbers have been updated.
1996	2	4	2691	2702	Given that oven systems of a heat recovery coking plant differ clearly in design comparing with a conventional coking plant, does Figure 4.3.2, along with the showing flow diagram and emission sources, apply to a heat recovery coking plant? If not, the reviewer would suggest the authors provide another Figure to show the flow diagram and emission sources of a heat recovery coking plant.	DAN YU TIAN	Accepted with modification	The figure 4.3.2 has been revised appropriately. The process in the diagram have been generalised, and apply to both heat recovery and not-heat recovery plants.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
2910	2	4	2695	2696	The text of the flow diagram is not distinguished	Poot-Delgado Carlos Antonio	Accepted	The figure has been redrawn.
1398	2	4	2695	2696	Figure 4.3.2 is not entirely legible as a half-page figure; suggest making this a full-page figure.	Robert Lanza	Accepted	The figure has been redrawn.
1998	2	4	2708	2709	There should be a comma or semicolon between "… a conventional coking plant" and "" recovery of the heat of …"	DAN YU TIAN	Accepted	Sentence modified.
2000	2	4	2709	2709	Text error, "cooking" should be "coking"	DAN YU TIAN	Accepted	Typographical error corrected.
1400	2	4	2714	2714	Suggest adding flaring of coke oven gas to Table 4.3.4 as a separate line intem	Robert Lanza	Accepted	Flaring has been added to the table.
3408	2	4	2715	2716	In Table 4.3.4, Fugitive gas emssion from "coking" production stage might be double counting of emissions from iron and steel sector, because when emissions from coke production are estimated by Carbon mass balance following the G/L in the IPPU(Vol.3, Ch.4), it counts the total carbon in that process	Eunae Seo	Accepted	Setence added: "Inventory compilers who are using a carbon mass balance approach to estimate emissions from the iron and steel sector, and are including fugitive emissions in this balance, should not use the methods in this section to estimate emissions to avoid double counting."
8546	2	4	2715	2716	The meaning of "N" is not described in likelihood of fugitive emissions of TABLE 4.3.4. "N = No"should be added.	Takuji Terakawa	Accepted	Definition of "N" added.
6024	2	4	2715	2716	There is no indication for the notation key "N"	RENATA GRISOLI	Accepted	Definition of "N" added.
2002	2	4	2715	2716	In Table 4.3.4, code "N" appears several times from the 3rd column to the 5th column with no explanation for its meaning. Does N=No?	DAN YU TIAN	Accepted	Definition of "N" added.
2004	2	4	2715	2716	In Table 4.3.4, the cell at 4th row and 7th column states that "Emissions from the fuel used to heat the coke batteries should be reported in the energy sector using the methodologies set out in the stationary combustion chapter". Does this statement (including the methodologies set out in the stationary combustion chapter) also apply to heat recovery coke ovens? If not, the reviewer would suggest the authors to provide a methodological guidance for estimating CO2 emissions from the flue gas of a heat recovery coke oven.	DAN YU TIAN	Noted	Yes, it does apply to heat recovery ovens. Some fuel use will be needed to start the heat recovery coke ovens from "cold". Flue gas combustion from a heat recovery coke oven would be estimated using the methods set out in the stationary combustion chapter.
2006	2	4	2715	2716	Texts in the cells at the 6th and 7th columns at the last row are too similar to those texts referring to coke pushing. The reviewer understands that coking quenching may have a different emission profile than coking pushing, as hot coke may react with water during wet coke quenching.	DAN YU TIAN	Accepted	The text has been revised.
7564	2	4	2717	2717	In the Figure 4.3.3, there are still items "Under development".	Coralie JEANNOT	Accepted	The decision tree has been finalised.
1962	2	4	2717	2717	An error was found in the Figure 4.3.3. For countries where coke production is a key category, the arrow should start from the rhombus, not from the rectangle.	DONGKOO KIM	Accepted	The decision tree has been finalised.
1964	2	4	2717	2717	An typo was found in the Figure 4.3.3. The expression "Is coke production key category?" needs to be corrected as "Is coke production a key category?".	DONGKOO KIM	Accepted	The decision tree has been finalised.
3968	2	4	2717	2718	The decision tree diagram is not complete- what does "underdevelopment" mean?.	Andrea TILCHE	Accepted	The decision tree has been finalised.
1966	2	4	2717	2718	There is not enough explanation about the choice of methods in the text. Adding enough explanation will make readers understand the logical flow of decision tree in Figure 4.3.3.	DONGKOO KIM	Accepted	The decision tree has been finalised.
704	2	4	2717	2718	It is proposed that the authors further elaborate on the decision tree in Figure 4.3.3 to include the guidance on tier 1 method and fill in the bottom block.	Mikhail Gitarskiy	Accepted	The decision tree has been finalised.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
2008	2	4	2717	2718	The arrow line approaching Square box “Collect data for higher Tiers” should originate from Diamond box “Is coke production key category?”, instead of from the blank Square box.	DAN YU TIAN	Accepted	The decision tree has been finalised.
4582	2	4	2717	2718	Disappointing to have an incomplete decision tree in a SOD.	Ole-Kenneth Nielsen	Accepted	The decision tree has been finalised.
1402	2	4	2717	2728	Figure 4.3.3. is unfinished.	Robert Lanza	Accepted	The decision tree has been finalised.
1404	2	4	2727	2727	Edit "… because of the high expenitures required for …"	Robert Lanza	Accepted	The word expenditure has been changed to cost.
8548	2	4	2729	2762	Although a tier 2 method is described in the decision tree, there is no description of the tier 2 method in the guideline text. The description on the tier 2 method should be added in the guideline text as well.	Takuji Terakawa	Accepted	The decision tree has been finalised. The decision tree refers to the methods discussed in the text.
706	2	4	2732	2745	It is proposed that the authors elaborate on the Equations 4.3.2 and 4.3.3 to include all greenhouse gases subject to reporting.	Mikhail Gitarskiy	Rejected	Looking at Volume 2, Stationary Combustion, the form of the equation that has been used is consistent with equation 2.1.
6146	2	4	2739	2739	I suggest that the authors add a brief explanation on Tier 2.	Naofumi Kosaka	Accepted	The section on choice of methods has been rewritten to include explanations of Tier 1, 2 and 3 methods.
1406	2	4	2742	2742	Edit "…based on coke production processing stage and…"	Robert Lanza	Accepted	The text has been revised.
1408	2	4	2754	2754	Edit "… detailed fugitive emissions predictive model."	Robert Lanza	Accepted	The text has been simplified.
1410	2	4	2755	2755	"Any models should be verified." Suggest providing a reference to standards/guidelines for model verification, or other discussion of expectations of how models should be verified	Robert Lanza	Accepted	A cross reference to other parts of the 2006 GLs or the 2019 Refinement has been provided.
1412	2	4	2762	2762	Edit "… Section 4.1 of this Chapter."	Robert Lanza	Accepted	Text added.
1414	2	4	2766	2766	Table 4.3.5 "Note: Factor for "hard coal coke production (coking plants)" -- The inclusion of this note suggests that there are other types of processes to which this emission factor does not apply. Suggest clarifying why this note is included.	Robert Lanza	Accepted with modification	Further clarification about the applicability of the emission factor has been added in the notes to the table.
2010	2	4	2766	2767	The statement is too simple to implement. Can the authors give more operational instructions on how to verify or evaluate that the emissions from coke production are realistic in magnitude in comparison with emissions from other categories in the iron steel sector, and the energy sector?	DAN YU TIAN	Accepted with modification	Text elaborated, and moved to the section on QA/QC.
1416	2	4	2774	2774	Edit "… from energy balance data or from plant operationss."	Robert Lanza	Accepted	Text corrected.
3970	2	4	2775		Table 4.3.6 seems not to be referred to in the text.	Andrea TILCHE	Accepted	A reference to the table has been added in the text.
1418	2	4	2775	2776	Suggest [throughout the guidelines, not only for this section] replacing "order of magnitude" with an actual range of numerical values, percentages, or other factors that should be applied by inventory compilers to the uncertainty assessment."	Robert Lanza	Accepted	
1420	2	4	2776	2777	Section headings are missing from the "Flaring of Emissions" text. "Flaring of Emissions" text should include headings for "Methodological Issues" "Choice of Methods, Decision Trees, Tiers" and other headings that are common to other sections.	Robert Lanza	Accepted	These sections and associated text have been added.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
6956	2	4	2777	2777	This row stated: "Surplus coke oven gas may be flared if no other economic uses have been found for it." In Hungary, besides surplus coke oven gas, also surplus blast furnace gas is flared in special cases (e.g. avoid to high pressure in the system). This flaring takes place in a power plant which is built to use these gases as energy sources. Would it be possible to add also a recommendation on where to allocate emissions from flaring of blast furnace gas?	Klára Tarczay	Accepted	The text has been modified to include a reference to flaring for operational safety reasons. Box 4.1 has been added for a summary of flaring activities in metallurgical coke and iron and steel production.
1422	2	4	2777	2777	"Surplus coke oven gas may be flared if no other economic uses have been found for it." In the Iron and Steel and Metallurgical Coke section (Chapter 4, Volume 3, Table 4.1a, it is implied that COG would be flared in the event of "emergencies or COG consumer maintenance" and not only because there is no economic use for the COG. the discussions of COG flaring should be made consistent. Also, if COG is being flared because there is no economic use for it, such flaring would not be "unintentional" but would actually be an inherent and routine part of the coke production process.	Robert Lanza	Accepted with modification	The text has been modified to include a reference to flaring for operational safety reasons. The IPCC definition of fugitive emissions includes both intentional or unintentional release of greenhouse gases.
6148	2	4	2780	2780	I suggest that the authors reconsider the correspondence between activity data and emission factor for flaring of surplus coke oven gas. If the default emission factors provided in line 2795 through 2797 are applied to estimate the emissions, the corresponding activity data should be the amount of surplus coke oven gas. However, the amount of coke production is selected as activity data in the proposed tier 1 method (Equation 4.3.4). If the authors wish to use the amount of coke production, an emission factor should be developed.	Naofumi Kosaka	Accepted	The equation has been corrected and the EF and AD are now presented in compatible units.
2012	2	4	2780	2780	Based on the followed section “choice of emission factor” and “choice of activity data”, the reviewer believes that the texts “based on coke production activity” should be modified as “based on the amount of COG flared”.	DAN YU TIAN	Accepted	The equation has been corrected and the EF and AD are now presented in compatible terms.
2014	2	4	2785	2785	Error in equation 4.3.4. Emissions GHG = Activity coke production● Emission Factor GHG should be Emissions GHG = Activity COG flared● Emission Factor GHG	DAN YU TIAN	Accepted	The equation has been corrected and the EF and AD are now presented in compatible terms.
2016	2	4	2787	2787	The texts “emissions of a given GHG by coke production (kg GHG)” should be modified as “emissions of a given GHG from flaring of coke oven gas (kg GHG)”.	DAN YU TIAN	Accepted	The equation has been corrected and the EF and AD are now presented in compatible terms.
1424	2	4	2787	2796	The emission factor referred to in line 2789 is in units of kg GHG per tonne of coke produced; the emission factor referred to in line 2796 is in units of kg GHG per TJ of coke oven gas. These emission factors are not consistent. For flaring the amount of COG flared (in units of TJ) must first be known, and then the GHG emission factors for COG flaring (combustion) must be applied. The amount of coke produced is not relevant to the GHG emissions calculation for flaring unless it is being assumed that 100 percent of the COG produced by the process is being flared.	Robert Lanza	Accepted	The equation has been corrected and the EF and AD are now presented in compatible terms.
1426	2	4	2787	2796	Suggest including two calculations and associated equations for COG flaring: 1. assume that 100 percent of the COG produced by the process is being flared; 2. assume that some subset of the total COG produced by the process is being flared. Calculation assumption 1. can be based on the amount of coke produced, the amount (tonnes) of COG produced per tonne of coke produced (TJ COG produced per tonne coke produced), and the emission factors or COG combustion (kg GHG/TG COG). Calculation assumption 2. would depend upon knowledge of how much (in units of TJ) of the total COG produced by the process is being flared.	Robert Lanza	Rejected	The equation has been corrected and the EF and AD are now presented in compatible terms. Inventory compilers can make their own choice about the assumptions about the quantities of COG flared.
2018	2	4	2788	2788	“Activity coke production = amount of coke produced (tonnes) “ should be “Activity COG flared = amount of COG flared (TJ)”	DAN YU TIAN	Accepted	The equation has been corrected and the EF and AD are now presented in compatible terms.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
2020	2	4	2789	2790	“emission factor according to COG released for each GHG (kg GHG/tonne of coke production)” should be “emission factor according to COG flared for each GHG (kg GHG/ TJ of COG flared)”	DAN YU TIAN	Accepted	The equation has been corrected and the EF and AD are now presented in compatible terms.
1428	2	4	2796	2796	Edit "… the Tier 1 emission factors for flaring (combustion) of coke oven gas …"	Robert Lanza	Accepted	
4584	2	4	2796	2797	Do you expect the CH4 EF for combustion in boilers to be representative for flaring?	Ole-Kenneth Nielsen	Accepted with modification	The guidance on the choice of emisson factor has been modified.
1430	2	4	2800	2800	See comments for Lines 2787 - 2796; Tier 1 activity data could be the amount of coke produced and the amount of COG produced per tonne of coke produced IF it is assumed that all of the COG produced is being flared. Otherwise the Tier 1 activity data would need to be the amount of COG flared (in units of TJ). If there was "no economic use" for the COG, it could be assumed that 100 percent of the COG would be flared.	Robert Lanza	Accepted	The equation has been corrected and the EF and AD are now presented in compatible terms.
3972	2	4	2814		Is there a need for further guidance? Not clear	Andrea TILCHE	Accepted	The text has been elaborated and the placeholder in parenthesis reminding the authors to elaborate the text has been removed.
708	2	4	2823	2991	It is proposed to move Section 4.3.2.4 (lines 2823 to 2991) to Appendix 4a.3 as the basis for future methodological development. The current text in Appendix 4a.3 could be merged with the text in Section 4.3.2.4.	Mikhail Gitarskiy	Rejected	As there was enough data to develop this section, the authors and CLAs agreed that this text should not be placed in an Appendix.
7446	2	4	2824	2826	coal to gas used to be a common way in cokeries to generate town gas - please provide a reference where to report these emisisons (e.g. chapter 3.11 - "Hydrogen Production" or 1.A.2)	Jens Reichel	Rejected	Although it is possible to use the outputs of CtL to Hydrogen Production, the process analysed in the 2019 Refinement 2006 Guidelines was restricted to the Syngas production.
2022	2	4	2848	2848	Word error. “CtL plan CO2” should be “CtL plant CO2”	DAN YU TIAN	Accepted	The text has been revised.
2024	2	4	2851	2851	The reviewer would suggest the authors to add a time frame to define the “conservative estimate of 120 million tons of CO2 equivalent”. Per year maybe?	DAN YU TIAN	Accepted	The sentence now reads "...conservative annual estimate of 120 million tons of CO2 equivalent".
3974	2	4	2869		Table 4.3.7 seems not to be referred to in the text.	Andrea TILCHE	Accepted	The table is now referenced.
3976	2	4	2899		Figure 4.3.8 should be Figure 4.3.5 - it seems.	Andrea TILCHE	Accepted	The figure number has been adjusted.
2026	2	4	2901	2904	“Fuel transformation processes” appears 4 times in Figure 4.3.5. The reviewer would suggest the authors to change them all into “gasification transformation processes”	DAN YU TIAN	Accepted	The figure has been revised.
6150	2	4	2905	2967	I suggest that the authors reconsider the correspondence among activity data and emission factor for the fugitive emissions from coal to liquids. Line 2967 states that "The activity data required for a Tiers 1 and 2 are the amounts of syngas produced." However, line 2916 and 2928 require "total amount of feedstock of type i" as activity data. The description shown above is inconsistent.	Naofumi Kosaka	Accepted	It was corrected. The activity data of CtL is the amount of syngas produced.
2656	2	4	2911	2921	Please list the unit of the variables.	Xiangzheng Deng	Accepted with modification	Equation 4.3.5 was deleted.
2476	2	4	2911	2921	please check the units of variables in the formula	Mingshan Su	Accepted with modification	Equation 4.3.5 was deleted.
290	2	4	2915	2919	Could you, please, unify the capital letters below the equation 4.3.5.	Sergii Shmarin	Accepted	Equation 4.3.5 was deleted.
2028	2	4	2917	2917	The dimensional unit for CFi was wrong. It should be “kg C/TJ” instead of “fraction”.	DAN YU TIAN	Accepted	Equation 4.3.5 was deleted.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
2030	2	4	2919	2919	The explanation of “EF” was wrong. It should be the conversion factor or the ratio of carbon emitted as CO2 (including carbon monoxide emitted to the atmosphere as the molar equivalent amount of CO2) to the total carbon contained in the feedstocks, expressed as a fraction, instead of “aggregate CO2 emission factor, kg CO2/TJ”	DAN YU TIAN	Accepted	Equation 4.3.5 was deleted.
2032	2	4	2944	2944	“The ultimately affects …” should be “They ultimately affects …”	DAN YU TIAN	Accepted	The paragraph has been reworded.
3978	2	4	2952		Table 4.3.14 does not seem to exist in the text.	Andrea TILCHE	Accepted	Table number corrected to 4.3.10.
3980	2	4	2956		Table 4.3.8 is not referred to in the text - it seems.	Andrea TILCHE	Accepted	The table is now referred to in the text.
2034	2	4	2956	2957	The dimensional units of the emission factors for gasification processes of CtL as shown in Table 4.3.8, may not be consistent with Equation 4.3.5 and 4.3.6, which use the amount of feedstocks, instead of output, as activity data.	DAN YU TIAN	Accepted	Equation 4.3.5 was deleted and the equation 4.3.6 units were corrected to be consistent with table 4.3.8.
3982	2	4	2964		Table 4.3.9 is not referred to in the text - it seems.	Andrea TILCHE	Accepted	The table is now referred to in the text.
3984	2	4	2967		The word "activity" is not spelt correctly	Andrea TILCHE	Accepted	Spelling mistake corrected.
2036	2	4	2967	2967	This sentence states that “the actvity data required for a Tiers 1 and 2 are the amounts of syngas produced in terajoules (TJ)”. Nevertheless, Equation 4.3.5 and 4.3.6 use the amount of feedstocks, instead of output, as activity data. The reviewer would suggest the authors to check and make appropriate modification to keep consistency of the methodological guidance. By the way “The actvity data” should be “The activity data”	DAN YU TIAN	Accepted	Equation 4.3.5 was deleted and the equation 4.3.6 units were corrected to be consistent with table 4.3.8.
1866	2	4	3027	3028	More specific QA/QC procedures for fugitive emissions can be provided here. In particular, energy accounts under the System of Environmental-Economic Accounting (SEEA) provide information on energy losses during extraction, distribution, storage and transformation of energy products. These losses cover resident economic units and are reported by industry, according to the International Standard Industry Classification. The economic statistics sections of many countries' National Statistical Offices (NSOs) produce these accounts, including EU countries (where it is mandated). Making mention of specific independently compiled data sets such as SEEA energy accounts can facilitate the QA/QC procedure for fugitive emissions. Existing bridging tables between SEEA air emission accounts and IPCC reporting can furthermore faciilitate the effectiveness of using SEEA air emission accounts in the QA/QC process. Bridging tables for air emissions accounts can be found on pg. 51 and 85 of the Eurostat air emissions handbook (http://ec.europa.eu/eurostat/documents/3859598/7077248/KS-GQ-15-009-EN-N.pdf/ce75a7d2-4f3a-4f04-a4b1-747a6614eeb3) and on pg. 14 of the EU regulation on envrionmental economic accounts (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02011R0691-20140616&from=EN).	Jessica Chan	Accepted	The text has been updated and revised.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
2130	2	4	3027	3028	More specific QA/QC procedures for fugitive emissions can be provided here. In particular, energy accounts under the System of Environmental-Economic Accounting (SEEA) provide information on energy losses during extraction, distribution, storage and transformation of energy products. These losses cover resident economic units and are reported by industry, according to the International Standard Industry Classification. The economic statistics sections of many countries' National Statistical Offices (NSOs) produce these accounts, including EU countries (where it is mandated). Making mention of specific independently compiled data sets such as SEEA energy accounts can facilitate the QA/QC procedure for fugitive emissions. Existing bridging tables between SEEA air emission accounts and IPCC reporting can furthermore faciilitate the effectiveness of using SEEA air emission accounts in the QA/QC process. Bridging tables for air emissions accounts can be found on pg. 51 and 85 of the Eurostat air emissions handbook (http://ec.europa.eu/eurostat/documents/3859598/7077248/KS-GQ-15-009-EN-N.pdf/ce75a7d2-4f3a-4f04-a4b1-747a6614eeb3) and on pg. 14 of the EU regulation on envrionmental economic accounts (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02011R0691-20140616&from=EN).	Julian Chow	Accepted	The text has been updated and revised.
2912	2	4	3716	3717	The text of the flow diagram is not distinguished	Poot-Delgado Carlos Antonio	Accepted	Heading for Figure 4a.2.3 edited to read “Proposed decision Tree for estimating Fugitive Emissions from Wood Pellet Production”. This makes the text distinguished.
2038	2	4	3808	3808	The dimensional unit for CFi was wrong. It should be “kg C/TJ” instead of “fraction”.	DAN YU TIAN	Accepted	The equation was reviewed and modified to [$E_{GAS\,i} = (FS_j \bullet EF_i) \bullet 10^{-6}$]. In other words, to calculate GHG emissions (CO_2, CH_4 and N_2O) from BtL and BtG, is necessary multiply the total amount of biomass or syngas produced (TJ) to the Emission Factor of biomass or syngas.
2040	2	4	3809	3809	The explanation of “EFi” was wrong. It should be the conversion factor or the ratio of carbon emitted as CO2 (including carbon monoxide emitted to the atmosphere as the molar equivalent amount of CO2) to the total carbon contained in the feedstocks, expressed as a fraction, instead of “aggregate gas i emission factor, kg gas i/Gg or TJ of feedstock j”	DAN YU TIAN	Accepted	The equation was reviewed and modified to [$E_{GAS\,i} = (FSj \bullet EFi) \bullet 10^{-6}$]. In other words, to calculate GHG emissions (CO_2, CH_4 and N_2O) from BtL and BtG, is necessary multiply the total amount of biomass or syngas produced (TJ) to the Emission Factor of biomass or syngas.
2042	2	4	3845	3845	The explanation of “EFi” was wrong. It should be the conversion factor or the ratio of carbon emitted as CO2 (including carbon monoxide emitted to the atmosphere as the molar equivalent amount of CO2) to the total carbon contained in the feedstocks, expressed as a fraction, instead of “aggregate gas i emission factor, kg gas i/Gg of feedstock j”	DAN YU TIAN	Accepted	The equation was reviewed and modified to [$E_{GAS\,i} = (FS_j \bullet EF_i) \bullet 10^{-6}$]. In other words, to calculate GHG emissions (CO2, CH4 and N2O) from BtL and BtG, is necessary multiply the total amount of biomass or syngas produced (TJ) to the Emission Factor of biomass or syngas.
354	2	4			My comments on the FOD were mainly aimed at the sometimes in my view too many signifianct digits provided for many default emission factros. I noted that these comments have not been resulted in changing these values. So I ask you to lookk at this again. I have no forther comments.	Tinus Pulles	Accepted	
8858	2	4			Default emission factors for fugitive emissions are generally too coarse. More refined data at more granular geographic level would be more helpful.	MINGMING WANG	Rejected	In general, limited data are available for fugitive emission sources, and providing more granular factors would not necessarily improve accuracy of the estimates.
7452	2	Annexes	17	18	where to report CO2 emissions? E.g from flaring of coke oven gas (Vol 2 chap 4 line 4792 f)	Jens Reichel	Accepted	
7450	2	Annexes			worksheets require CO2, CH4 and N2O - in the volume 2 chap 4 NMVOC emission factors are provided - where to report NMVOC?	Jens Reichel	Rejected	Per 2006 GL, we are not including NMVOC in the worksheets.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
3412	2	4	87	87	co2 and ch4: letter case.	Håkon F. Skullerud	Accepted	
8850	2	2	19		No refinment was made to Tables 2.2, 2.3 and 2.4. However, default emission factors for stationary industrial combustion are considered too general, and it is recommended that IPCC expands the disaggregation by types of equipment (boilers, furnaces, etc.), technology and capacity, to reflect difference in emissions from different types of equipment.	MINGMING WANG	Rejected	No action can be taken because comment is out of scope of 2019 Refinement.
656	2	2	56	57	Section 12.5, Chapter 12, Volume 4 (AFOLU) of the 2019 Refinement does not provide the guidance on how CO2 emissions from buring woody biomass feedstocks should be treated in the Energy sector. Therefore, it is proposed to include the following text in line 56: "The CO2 and non-CO2 emissions from burning wood biomass for energy purposes may be reported in the same country or in different countries. It is good practice to identify the approach applied for reporting on CO2 emissions in the country, where the energy feedstocks from harvested wood were produced. The country should decide on inclusion of CO2 emissions from wood biomass burning in national inventory totals in the Energy sector depending on the approach for reporting CO2 emissions and removals applied by the country-producer of the HWP." The existing text in lines 56 and 57 remains unchanged and wouldfollow the inclusion proposed.	Mikhail Gitarskiy	Accepted with modification	Accepted with modification. Additional detail on treatment of biomass has been provided in 2.3.3.4, and the text directs users to Section 12.5, Chapter 12 of the AFOLU volume for additional information on HWP
7992	2	2	2.3.3.4		I agree with the idea of treating biomass as a special case. However, we must make the proviso that emissions from the combustion of biofuels have only an informative purpose, which are not included in the totals to avoid double counting, leaving me the concern of whether that decision is lost or not it is recognized as a proportion of the total. And my final question, does it exist or can we establish some measurement methodology that allows us to disaggregate the data by source of GHG emissions? If the interest of the data is to use it as a focal point to establish public policies aimed at reducing GHGs, then it is convenient to disaggregate it.	Alma Vargas	Accepted with modification	Additional detail on biomass has been provided in the FD. Emissions from biomass combustion are estimated with methods available in the 2006 IPCC guidelines, volume 2, chapter 2: Stationary Combustion.
8852	2	3			The FOD does not contain any update to section 3.6 Civil aviation. Sub-national governments often do not have access to airport and flight data, whereas national government or agencies mostly do. Therefore, it is strongly recommended that IPCC requires national inventories to report aviation emissions per airport and even per flight where possible.	MINGMING WANG	Rejected	No action can be taken because comment is out of scope of 2019 Refinement.
8854	2	3			To improve modelling of LTO emissions, it is strongly recommended that IPCC expands the EEA methods to provide average taxi-time data for airports outside EU and USA, and to update the current ICAO default values of taxi-time becuse they are quite rough and likely too high for small and medium sized airports and too low for poorly managed large airports.	MINGMING WANG	Rejected	No action can be taken because comment is out of scope of 2019 Refinement.
8856	2	3			Section 3.3.1.4 (Completeness) states that carbon from biomass should be estimated separately and reported as an information item to avoid double accounting, as these emissions are already treated in the AFOLU sector. Will the IPCC provide further guidance on emissions from combustion of renewable diesel (RD)? How can nations (and cities) share the accountability of emissions generated by the RD combustion, if RD is produced in a different country?	MINGMING WANG	Rejected	No action can be taken because comment is out of scope of 2019 Refinement.