Review Comments by Experts on Second Order Draft of Volume 5 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
7998	5	2			This chapter, unlike the previous ones, does not offer and does not cite methods of measuring GHG from solid waste, either by fires that occur in open dumps; fires that can be caused by third parties or autonomous by the presence of volatile substances that are combusted with oxygen. In countries like ours, the Dominican Republic, almost all solid waste landfills are open-pit, and fires are very common, which produce a large smoke that lasts up to a week, leaving a trail of pollution that not only affects the atmosphere, but also affects the people who reside in the neighboring cities and rural communities. Considering the above, it is very pertinent that techniques are developed to measure the volume and the dangerousness of these gases, in order to sensitize local governments that they must focus on establishing sanitary landfills in their territories and to classify the waste before disposal final to avoid further contamination of the environment. Obviously, awareness must reach households, companies and institutions, which is where waste is generated	Alma Vargas	Noted	No action can be taken because comment is out of scope of 2019 Refinement. In addition, Chapter 2 is dealing with waste data. Methodological issues for open burning are covered under chapter 5.
7974	5	2	1	end	Please see two uploaded files which should be consulted together:	Jean Bogner	Noted	No action can be taken because comment is out of scope of 2019 Refinement.
3274	5	2	101	101	101 UPDATING FROM 2006 IPCC GUIDELINES. Country-specific data It is desirable that each country use specific data about its territory on the generation, composition and management practices of the DSM as a basis for the estimation of its emissions. Therefore, as part of the implementation of good practices, efforts should be made to promote the generation of official waste statistics in the countries, as well as the use of standardized activities in the collection of sampling data in the SEDS. Preferably, country-specific data should be obtained for the generation, composition and management practices of the DSMs from official statistics on waste generated by national statistical agencies, municipalities or other relevant government agencies, as well as by elaborate surveys by companies or waste management organizations, among others; or in its absence, through research projects (World Bank, OECD, IDB, JICA, U.S. EPA, IIASA, EEA, etc.). Large countries, with marked differences in the generation and treatment of waste from one region to another, are recommended to use data from those regions, as far as possible. See Chapter 2, Methods for Data Collection, of Volume 1, for more guidance on general data collection and waste surveys.	Pablo Aviles Hernández	Accepted with modification	The part related to the use of country specific data and surverys are included in the 2019 Refinement from the 2006 IPCC Guidelines in this section to clarify that it was not deleted.
4918	5	2	122	134	In the text (as in lines 146 to 147) you added information on VSS (and TSS), and type of sludge (raw/stabilized). But in table 2.4 A there is no link with this information although it is said that "it is good practice to differentiate […]". So I don't really understand what for this information on TSS and VSS is provided. If it is for referencing purpose of the DOC values, it could be more transparent just to add the information as a note in the table 2.4A. Moreover, if it is good practice to differentiate between raw and stabilized sludge, UNFCCC reviews will expect annex 1 countries to do it. Please could you provide separate defaults values for carbon content, nitrogen content and DOC ?	Céline Gueguen	Accepted	The section 2.3.2 was fully redrafted to clarifiy the TSS and VSS issues.. Also table2.4A provided default value of treated and untreated sludge.
4916	5	2	128	128	It is indicated in the text that it is "good practice to split between "BIODEGRABLE" and "FOSSIL" shares…". Do you mean between "biogenic" and " fossil" ? I guess yes (for CO2 emissions purpose), so it will be more transparent and consistent with the other part of the GL to use this wording “biogenic”.	Céline Gueguen	Accepted with modification	The sentence has been deleted as it may cause confusion.

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2548	5	2	136		'In wet basis' is suggested to be written as 'on wet basis'	Muhammad Mohsin Iqbal	Accepted	Sentence has been changed
8878	5	2	139		Table 2.1 in FOD also contained data for Melanesia, Micronesia and Polynesia. They are now missing from the SOD.	Mingming Wang	Accepted with modification	SOD contains the available information on waste generation rates for Fiji, Solomon Islands, Vanuatu (Melanesia) and Tonga (Polynesia) that is the same as for FOD. Data were neither added nor deleted for mentioned regions in the SOD.
8880	5	2	139		In Table 2.3, the % of all composition categories for each region add up to 101% or 99%, not 100%. Please rectify.	Mingming Wang	Noted	Footnote number 2 below the table explains the reasons for such descrepancy.
7714	5	2	139	140	For Same reason in comment for Table 2.1, I will recommand to delete Table 2.3 and regional (mean) value in Annex 2A.2.	Masato Yamada	Rejected	Regional values are included so that they can be used for countries which do not have data. Therefore, this table cannot be deleted.
6202	5	2	139	140	Table 2.3: Region Western Europe: This table has been updated. The total of all waste types including "others" now amounts to 100%. The waste type "others" still is very high (29,1%). For this type the content of organic carbon content can not be determined. It would be helpful, if the waste types in table 2.3 correspond to the waste types in Line 122 (especially "nappies" and "garden (yard) and park waste" are missing in table 2.3	Christoph Lampert	Accepted	Available data for nappies and garden and park waste was included in table 2.3. Also, guidance has been added in the text on how to handle nappies and garden and park waste.
7716	5	2	150	151	To be consistent with Table 2.4A, this sentense should be "Sewage, food industry, paper industry, textile industry and chemical industry will generate organic sludge".	Masato Yamada	Accepted	The section 2.3.2 was fully redrafted
2550	5	2	158		'were added' is suggested to be changed to 'was added'	Muhammad Mohsin Iqbal	Accepted	The section 2.3.2 was fully redrafted.
7718	5	2	161	162	What is "WWT" sludge?	Masato Yamada	Accepted with modification	The word has been changed to "wastewater"
4168	5	2	161	162	The use of uncertainty in percent makes this table abiguous. What does the percent of uncertainty refer to (percent of dry matter as shown in the caption, or percent of the resulting carbon content)?	Andrea Tilche	Accepted	These are percents of uncertainty of the value in preceding column. Column headings were updated.
2552	5	2	176	177	The sentence 'Information C and N content... waste water and agriculture', is not clear. May please be clarified.	Muhammad Mohsin Iqbal	Accepted	The section 2.3.2 was fully redrafted .
4170	5	2	176	181	This entire section is poorly written and needs to be reworded.	Andrea Tilche	Accepted	The section 2.3.2 was fully redrafted
8882	5	2	188		In Annex 2A.1, for countries with empty cells, does it mean data not available or not applicable (none-existent)? And if country level data is not available, is the default approach to use regional data? Please clarify.	Mingming Wang	Accepted	A footnote has been added under the table to clarify that blank cells means that no data is available and that regional data can be used in such cases.
8726	5	2	188	188	Table 2A1. Isn't this table a little inconsistent with the Table 2.1? For example Southern Asia moved from 0.21 to 0.5 t/cap/year but when I look at the countires the only one that has a value larger than 0.5 is Maledives (0.91) so how come that the suggested default for the region is 0.5?	Zbigniew Klimont	Accepted with modification	The authors are very thankful for such detailed analysis of tables 2A.1 and 2.1, eg. for region of Southern Asia. In SOD, the value for Sri Lanka is missing. Taking into account that the MSW generation per capita for Sri Lanka is equal to 1.86 t/cap/year the average MSW generation for Southern Asia region is equal to 0.50 t/cap/year. The data for Sri Lanka is added to the table.
4920	5	2	189	189	In order to increase the transparency of annex 2A2, please add a table including the title of column at the beginning of each column.	Céline Gueguen	Accepted	Corrected as suggested
4922	5	2	189	189	Table 2A2 : Please consider that, for many countries, the default value for the category "other" is very high. Considering the list of of waste (ligne 122), this category is supposed to include "(2) garden waste", "(6) nappies" and "(11) other (e.g. ash, dirt, dust, soil, electronic waste). So, this category covers type of wastes very different in terms of DOC, carbon content (FC) and fossil carbon content (FCF) (see 2006 GL, vol 5, Chap 2, table 2.4) and therefore in terms of CH4 emission . There is a riskq that countries make a link between the "other" category in the composition table (2A2) and the "other, inert waste" category in table of default values proposed in the the2006 GL . This would result in an underestimation of emissions.	Céline Gueguen	Accepted	We consider disaggregate Other to nappies and garden waste to be more in line with Waste model. Available data for nappies and garden and park waste was included in table 2.3. Also, guidance has been added in the text on how to handle nappies and garden and park waste.
4924	5	2	189	189	Waste composition provided for France is supposed to come from Dong Qing Zhang et al. (2010) "Municipal solid waste management in China: Status, problems and challenges". This document does not include any waste composition for France. Please check the references.	Céline Gueguen	Accepted with modification	The data for France used are from the 2018 NIR.
2460	5	2	230	230	replace "imagery" by "spatial" in "higher imagery resolution"	Brice Mora	Noted	SOD Volume 5 Chapter 2 from lime 191-395 are references section. Comment is not in line with text in Chapter 2. It may belong to other Volume or other Volume.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
2458	5	2	234	234	replace "might introduce" by "may introduce".	Brice Mora	Noted	SOD Volume 5 Chapter 2 from lime 191-395 are references section. This comment is not in line with text in Chapter 2. It may belong to other Volume or other Volume.
4912	5	2	62	62	Table 2,1 - note 2 : "the per capita values should be multiplied with the population WHOSE WASTE IS COLLECTED […] this encompasses ONLY urban population." In the view of an inventory compiler for waste, capacity building to non annex 1 countries, this is not complete: rural population is also generating waste (maybe with another generation rate than urban one). These waste, even when not collected, are in some cases discharges in collective dumps out of the villages where anaerobic decomposition definitely occurs. These emissions must be considered in the inventory to ensure completeness. Otherwise there is an underestimation. Therefore, in this view, the production ratio has to be multiplied with the TOTAL national population AND, the fact that a part of rural waste may not be disposed in dump/landfills could be considered using the parameter " fraction of MSW disposed to SWDS" (and therefore has to reflect that a part of national waste is not collected) OR could be considered using an additional national parameter "fraction of waste collected").	Céline Gueguen	Accepted with modification	The paragraph above table 2.1 and footnotes under tables 2.1 and 2 A.1 have been modified to clarify that for developing countries using regional waste generation rates provided in the updated Table 2.1 and for developing countries in italics in the Table 2 A.1, the generation rates should be multiplied by the urban population only to obtain the total waste generated in the country. The publication where data for most developing coutries are obtained "Hoornweg, D., and Bhada-Tata P. (2012). What a Waste: A Global Review of Solid Waste Management, Urban Development and Local Government Unit of the Sustainable, The World Bank, 116 pp.Development Network" explains in the methodology that the waste generation rates per capita are estimated based on total MSW generated in the country divided by the urban population. The total waste generated in the country includes all types and sources subjects of waste.
4914	5	2	62	62	Do the proposed default generation rates correspond to waste generated by the national population only ? What about very touristic areas/countries (islands especially) where a fraction of waste is generated by tourists ? Not considering tourists in the estimation of the amount of waste disposed in landfills may lead to an underestimation.	Céline Gueguen	Noted	The waste generation rates per capita, especially for developing countries, were taken from the publication "Hoornweg, D., and Bhada-Tata P. (2012). What a Waste: A Global Review of Solid Waste Management, Urban Development and Local Government Unit of the Sustainable, The World Bank, 116 pp.Development Network". The report explains in the methodology that the waste generation rates per capita are estimated based on total MSW generated in the country divided by the urban population. The total waste generated in the country includes all types and sources/subjects of waste, including from tourists. This is clear in the island- tourist countries such as Tonga, Fiji, etc. in table 2A.1.
2670	5	2	68	80	These two parameters are subject to change over time.....values provided in Tables 2.A.1 and 2A.2 can be used. This part does not cover details of the factors that influence municipal domestic waste. I'd reocmmend reading Alexis M.and James R's "Sustainable recycling of municipal solid waste in developing countries".	Xiangzheng Deng	Accepted	The authors agree with the comment from the reviewer. This is why different values for waste generation rates are provided in Table 2 A.1 so that the compliers can construct proper time series which takes change in generation rate over time. For waste composition, the available data from reference between the period 2005 and 2018 were used to obtain representative values for this period as data on composition for different periods are not available. Moreover, the waste composition does not change as rapid as the waste generation rates.
4162	5	2	69	69	Explain the term FOD as First Order Decay	Andrea Tilche	Accepted	revised as suggested
4164	5	2	74	74	Change "are also" to "also"	Andrea Tilche	Accepted	"are" have been removed
4166	5	2	82	189	The methodology defines a range of different MSW management options, of which the unspecified also covers recycling (at least for some countries), and for some countries this fraction covers 60% or more. Given that this category may cover situations with both very low emissions (recycling) or relatively high, it is highly problematic to have a large proportion of unspecified. Also there should be a special category for recycled waste.	Andrea Tilche	Noted	Although the authors acknowledge the issue raised by the reviewer, unfortunately, data is not available to provide a specific category for recycling or treatment technologies other than those included in the table. If a country has the split of unspecified e.g. recycling, then the country may use the percentage of such treatment technolgy and subtract from the total of unspecified as per the guidance provided under section 2.2.1 in the 2006 IPCC Guidelines for country specific data (this part is copied back in the 2019 Refinement).
4654	5	2	87	98	In some countries, waste generated by tourists could be a substantial part of the total waste generation. It is not clear if/how this is taken into account.	Ole-Kenneth Nielsen	Noted	The waste generation rates per capita, especially for developing countries, were taken from the publication "Hoornweg, D., and Bhada-Tata P. (2012). What a Waste: A Global Review of Solid Waste Management, Urban Development and Local Government Unit of the Sustainable, The World Bank, 116 pp.Development Network". The report explains in the methodology that the waste generation rates per capita are estimated based on total MSW generated in the country divided by the urban population. The total waste generated in the country includes all types and sources/subjects of waste, including from tourists. This is clear in the island- tourist countries such as Tonga, Fiji, etc. in table 2A.1.

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6204	5	2	95	98	It is said that for developing countries the data provided shall be multiplied with the urban population. Does this mean that it can be assumed that the rural population in developing countries does not produce any waste?	Christoph Lampert	Accepted	The paragraph and footnotes under tables 2.1 and 2 A.1 have been modified to clarify that for developing countries using regional waste generation rates provided in the updated Table 2.1 and for developing countries in italics in the Table 2 A.1, the generation rates should be multiplied by the urban population only to obtain the total waste generated in the country since these rates assume that the waste is generated by urban population only and not rural population.
7710	5	2	99	100	For Table 2.1, rates in the table seems to arithmetical means of rates for each countries included in a certain region in Annex 2A.1. There are two problems for these representative values. First is that the simple arithmetical mean of rates is not adequate for this purpose because denominators of each rate are different. The representative value should be calculated as the sum of numerators over the sum of denominators (both are amount of waste) for all countries included in a certain region. Secondaly, countries in a certain region may be in similer social and climate conditions. However, their are in diverse economical level. The MSW generation rates, component of MSW and introduced waste management technologies is strongly affected to economy in a country. Then, the mean rate of a certain region is not adquate to use for a specific rate for a certain country. I think country specific values in Annex 2A.1 is enough to show default value in this guidline. So I will recommand to delete Table 2.1 and regional (mean) value in Annex 2A.1.	Masato Yamada	Noted	The purpose of updating the regional values in Table 2.1 (which was also used in 2006 IPCC Guidelines) is to provide default values for countries which do not have data. Therefore, the table will not be deleted. The idea of using the arithmatic mean is to provide an average for the generation rates in countries in similar regions which can be a good proxy for countries which don't have data. Therefore, estimating the average generation rate based on the total waste divided by the total population of the region will still have uncertainties. In many cases, the raw data is not availble and therefore, the simple arithmatic mean was used.
7712	5	2	99	100	Please show the mean of "-" in the table.	Masato Yamada	Noted	"-" is delete from table to be consistent across the chapter.
8724	5	2	99	99	Table 2.1. I am surprised to see that there is no numbers waste management for Southern Asia where India is central. To my knowledge there are several reports from the government, regional offices, and also research papers reporting/estimating waste generation for urban and rural population including estimates of collection efficiency, open duming and also burning or waste. Also the generation rate for MSW of 500 kg/cap/year seems to be rather high compred to often quoted rates of about 0.5 kg/cap/day (urban) and about 0.3 (rural) which woudl give even less than half of that; in fact probably about .16 ton/cap/year. As a matter of fact I suggest checking if the numbers in the column with MSW Generation are not in fact in kg/cap/day (?).	Zbigniew Klimont	Accepted with modification	The reference used for waste treatment practices in table 2.1 does not include data for India or other countries in Southern Asia. Therefore, no data was included for these countries. The reviewer did not provide any references to source data from. The value 0.5 t/cap/year is typical for this region and may be used for GHG emission estimation as a regional default value as well. In case counrty-specific data is available, it is good practice to use such data. Guidance on country specific data was added in section 2.2.1.
8884	5	3			Table 3.0 provides DOCf for different types of waste and also for bulk waste. It is unclear if a country/city should use the specific DOCf for different types of waste (based on the default fraction provided in Volume 5.2), or use the value for bulk waste because different types waste are not collected separately in some nations or areas. Please clarify.	Mingming Wang	Noted	It is recommended that the country should use specifc DOCf value for each waste category if waste composition are available to them. DOCf value for bulk waste should be used only when waste composition is not available. There is a footnote in Table 3.0 suggesting that bulk waste is used when waste composition is not known.
4810	5	3	1	392	Overall the text, though improved from the FOD, still needs thorough editting to improve readability - e.g Box 3.0A and 3.0B need substantial work	Fabiano Ximenes	Accepted with modification	Box 3.0A and 3.0 B are revised particulry with Box 3.0B. In Box 3.0 B, the information exerpted from the literatures regarding the evidence of DOC leacing from SWDS containing wet wastes during high rainfall events is provided. The latter part describing the DOC calculation procedure is removed as the box intends to provide information only.
796	5	3	104	104	Recommend replacing "pipes and certain the number of gas exhausting (ventilation) pipes" with "pipes and gas exhausting (ventilation) pipes"	Jeffrey Coburn	Accepted	Corrected as suggested.
798	5	3	107	107	Recommend replacing "of sunk of drainage pipe" with "of sunken drainage pipes"	Jeffrey Coburn	Accepted	Corrected as suggested.
800	5	3	109	109	Recommend replacing "In the case of drainage sunk, " with "In the case of sunken drainage pipes, "	Jeffrey Coburn	Accepted	Corrected as suggested.
2672	5	3	130	131	"Less decomposable wastes were wood components including tree branches and leaves (Eleazer et al., 1997) harvested wood products such as sawn and engineered wood materials. "This reference is from a book published in 1997, and I suggest to replace it with some literatures published after 2006.	Xiangzheng Deng	Accepted	More updated references are used for less decomposable waste (Wang et al. 2011, Wang and Balaz 2016, Ximines et al, 2018).
4816	5	3	130	131	Would be better to quote more recent studies that have included a wide range of harvested wood products - Eleazer's paper did not have that focus. Alternative text suggested: "Less decomposable waste include harvested wood products such as sawn and engineered wood materials (e.g. Wang et al 2011).	Fabiano Ximenes	Accepted	More updated references are used for less decomposable waste (Wang et al. 2011, Wang and Balaz 2016, Ximines et al, 2018).

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802	5	3	133	135	This sentence may read better as follows: "Structural organization of the organic matter in the waste materials, particularly the lignin-like residual fraction present, was found to be the predominant factor affecting their biodegradability (Bayard et al., 2017)."	Jeffrey Coburn	Accepted	Corrected as suggested.
4818	5	3	135	137	Suggested alternative text: "The biodegradation yield of the waste components under anaerobic condition varies greatly depending on the material type, ranging from minimal yield for wood and wood products (e.g Wang et al 2011) to high percentage (60-80%) for food wastes and office paper (Eleazer et al 1997; Wang et al 2015).	Fabiano Ximenes	Accepted	Corrected as suggested.
4820	5	3	137	138	Suggest this alternative text: "Meanwhile, biogenic carbon conversion of paper products varies greatly (21 to 96% - REF) depending on the type of paper".	Fabiano Ximenes	Accepted	Corrected as suggested.
4822	5	3	140	140	Suggest deleting "Meanwhile the diaper exhibited limited biodegradability (Wang et al., 2015)" - out of context and already included in the range above, no need to single it out.	Fabiano Ximenes	Accepted	Deleted as suggested.
4824	5	3	143	145	Please rewrite - I made the suggestion to include the text, but not in this way - in order to be have a better flow from the previous sentences which talked about findings from lab based experiments please change to: "From landfill excavation studies, carbon loss for wood was found to be low and climate did not influence much on decay of wood in landfills - the observed higher levels of decay for some wood samples were attributed to differences in wood species rather than climate (Ximenes et al., 2015)."	Fabiano Ximenes	Accepted	Corrected as suggested.
3712	5	3	152	152	The recommended DOCf values are not yet included in the IPCC waste spreadsheet model. I assume this will happen in the final draft.	Hans Oonk	Accepted	The proposed DOCf values has integrated in the spreadsheet.
4826	5	3	152	152	Type of waste - first description would be more accurate if it stated instead "less decomposable wastes e.g. wood, engineered wood products and tree branches". Also please correct the spelling for "Ximenes et al 2018".	Fabiano Ximenes	Accepted	Corrected as suggested.
4174	5	3	153	174	This section introduces the accournting of DOC leaching as something to account for when estimating emissions from degradable organic carbon in SWDS. However, there is no concerns that the degradability of the leaching DOC could be different from that of the remaining DOC. Such differences in degradability are highly likely and should be accounted for.	Andrea Tilche	Accepted with modification	All DOC originally presented in solid waste should be accounted for in estimation of emission. Whenever the DOC lost with the leachate can be quantified and not considered in the estimation of emission in solid waste category, the emission arising during leachate treatment should be estimated. The degradability of DOC in leachate is likely to be different from the remaining DOC but accounted for in wastewater treatment and discharge
4828	5	3	154	154	"However, DOC leached from the SWDS was reported to be significant under extremely wet condition" - Reference required	Fabiano Ximenes	Accepted with modification	The references in which high rainfall intensity and high percentages of food waste reported to yield significant carbon lost from SWDS are provided in Box 3.0B.
6208	5	3	158	174	The introduction of lines 153-157 allow to skip Box 3.0B. The relevance of the DOC leaching is still based only on 1 literature (Zahn et al (2017)). Furthermore, several undefinded terms are used like "extremely wet conditions" of "high percentage of food waste". Furthermore, the sentence in line 160 and 162 is contradictory: "Recent literature reported that the operation of anaerobic landfills under wet conditions yielded higher organic carbon release in gas and leachate forms while reducing landfill gas production potential due to carbon washout by leachate (Jiang et al., 2007)." In the first part of the sentence higher organic carbon releases in gas are mentioned, in the second part a reduced landfill gas production is mentioned.	Christoph Lampert	Accepted with modification	The evidences of siginificant DOC leaching were reported in high rainfall intensity (Karanjekar et al., 2015) and high percentages of food wastes (Zhan et al., 2017) conditions. The extremely wet conditions refer to these reported conditions. The first sentence between line 160-162 is also revised mentioning high organic carbon in leachate yield lower gas production from SWDS.
4932	5	3	191	191	3 categories of SWDS have been added in the table. The "poorly managed semi-aerobically SWDS" is defined with very detailled managing conditions. These conditions may be known at the level of one site but could not be estimated at the national level. Even if a questionnaire is sent to the SWDS (for those which are not closed yet) the fraction ofd waste disposed in such condition may evolved from one year to another. Do you have examples of countries, having such a precise and exhaustive historical dataset of managing parameters of its landfills ? ...so, the criteria defining if a site is "poorly managed" is too "micro" (level of a site) and should be more "macro" to become really applicable by inventory compilers.	Céline Gueguen	Accepted with modification	Clear definition on criteria for well-managed active aeration has been given in Table 3.1, as well as responding to comments No.4796.
3238	5	3	191	192	Verify bibliographic citation format of table 3.1	Poot-Delgado Carlos Antonio	Accepted	Corrected as suggested.
3240	5	3	222	222	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted with modification	Information have been mentioned to reflect the same references from table 3.0 (New).

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4652	5	3	364	365	This is the only place where changes in the methane oxidation is mentioned as nessesary to consider. However, no guidance on how to consider this parameter is provided, and not mentioning of passive aerobation (i.e. biocover) is included in the revised guidelines!	Ole-Kenneth Nielsen	Rejected	Information in Appendix does not give the specific guidance of emission estimation. This part provides technical materials where emission is poorly understood or where there is insufficient information available. See the detail in Chapter 1.3, Volume 1 in original 2006 IPCC Guidelines.
804	5	3	376	376	Change "...and representative data is obtained." to "…and representative data are obtained."	Jeffrey Coburn	Accepted	Corrected as suggested.
778	5	3	49	49	Change "complier" to "compiler"	Jeffrey Coburn	Accepted	Corrected as suggested.
4806	5	3	49	50	This sentence implies that the document is about active aeration data, when that is only a minor component of the overall document. Should it say instead: "This refinement attempts to guide the inventory complier on estimation of CH4 emissions from SWDS sites to the extent of current knowledge and data available"	Fabiano Ximenes	Accepted	Corrected as suggested.
780	5	3	50	50	Change "current knowledge and data available" to "current knowledge and available data" for proper parallel structure of clauses	Jeffrey Coburn	Accepted	Corrected as suggested.
4644	5	3	57	58	In this sentence: "the fraction of the degradable organic carbon that decomposes under anaerobic conditions (DOCf)", "under anaerobic conditions" should be deleted	Ole-Kenneth Nielsen	Accepted	Corrected as suggested.
4808	5	3	60	60	"The parameter that is related to aerobic condition is expressed in terms of MCF." This sentence is unclear - need to explicity define what MCF is here.	Fabiano Ximenes	Rejected	Definition on MCF is given in orginal text in 2006 Guideline
3418	5	3	62	63	In this sentence 'many countries'countries is in contradiction with the part in between brackets '(e.g. Germany and some European countries)'. I think there is some implementation in Germany and USA, while in some other countries the option is explored in pilot projects.	Hans Oonk	Accepted	Corrected as suggested.
4812	5	3	63	64	"Decomposition of the organic matter is promoted about 3-4 times" - this sentence is incomplete - is the intention to say that under aerobic conditions decomposition is 3-4 times quicker than under anaerobic conditions? Please clarify	Fabiano Ximenes	Accepted	Corrected as suggested.
4814	5	3	66	74	This text would flow better if it was placed directly before the text in Line 61 - it seems out of place now.	Fabiano Ximenes	Rejected	Sequence of current sentences is to explain clearly about MCF. And the paragraph that you pointed out was modified to cover the refinment in this chapter appropriately.
782	5	3	69(→63?)	69	Add "an" prior to "abatement measure"	Jeffrey Coburn	Accepted	Corrected as suggested.
784	5	3	70	70	Change "This idea had also expanded for" to "This idea has also been expanded for"	Jeffrey Coburn	Accepted	Corrected as suggested.
4650	5	3	75	113	Provided the significant amount of literature on the impact of biocover on the methane oxidation rate, it seems strange not to include this type of managemenet design of SWDS in the guidelines. From a scientific point of view it makes sence to adjust the MCF for active aerated landfills as less methane is produced. However, for the biocover design, the process do not change the anaerobic conditions in the lower layers of the SWDS. Instead the technology aims at oxidising the methane moving upwards passing an aerobic compost top-layer through which the methane is oxidised to CO2. For this reason, a scientific explanatory approach would be to introduce biocover technology design specific values for the oxidation rate (resulting from introducing an aerobic compost/compost like material top cover layer at SWDSs).	Ole-Kenneth Nielsen	Noted	No action can be taken because comment is out of scope of 2019 Refinement.
3432	5	3	75	113	I think the methodology for estimating emissions from aerobic landfills is thin as ice, sice it is based on two demonstrations. It is at best a Tier 1 approach. When well designed, the actual MCF can be much lower than 0.4, as suggested by your interpretation of Hrad. Generally aeration pojects are well monitored and when monitoring data are made available by the landfills, this will open up the possibility of a higher Tier methodology, based on actual monitoringdata. To facilitate future inventory compiling and review, you need to mention a Tier-2 /Tier-3 method as well, based on actual on-site monitoring. Comparable to your (possible) interpretation of Hrad, site specific MCF might be estimated from the CO2/CH4 ratio in the extracted gas as (e.g. by assuming at a certain moment in time (MCF(t)) being equal to 1-CO2-CH4)/CO2+CH4). an alternative option is to calculate generation using a conventional FOD model and correct for the amount of C removed via gas extraction (similar to the correction of emissions for R at conventional landfills).	Hans Oonk	Accepted with modification	We address higher tier of methodology for on-site monitoring given in Appendix 3A.2 and we have added the instruction to refer it in the sentences.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
3420	5	3	79	80	You need a clear definition of an aerobic landfill. Line 79-80 can be interpreted as a definition, but is very vague 'in addition to air injection … certain design of piping … are required'. I read this as follows: 'having active air injection is insufficient to be qualified as an aerobic landfill. In order to qualify, it needs certain design'. This really leaves me confused. Either you need to elaborate 'certain design' into clear criteria, or you have to define aerobic landfills simply as a landfill with active air injection.	Hans Oonk	Accepted with modification	Clarification of definition was given in Box.3.0A (New) and Table 3.1 (Updated).
3422	5	3	86	88	There are several options to aerate landfills. Low-pressure aeration one of them. I do not understand this reference to low-pressure aeration in this sentence. As far as I know, low-pressure aeration is not convincinly demonstrated to be superior (reduced energy use; saving cost of production) to other ways of aerating. On the contrary Van Turnhout in his PhD-thesis performed CFD-calculations and demonstrated that the traditional design of low-pressure aeration (as promoted by IFAS with vertical wells with relative long filters, relative far apart) results in inhomogeneous aeration of waste, compared to a more densily welled system with low filter wells. So low-pressure aeration seems also to result in inhomogeneus aeration and a relative small proportion of the waste that is actually subject to aerobic degradation. Actual design, operation and efficiency of aerobic landfills is an ongoing discussion and there is no scientific agreement on what systems to promote. Please remove all references to low-pressure aeration from the text.	Hans Oonk	Accepted	Box 3.0A is the information on calculation of MCF for new category at the level of current knowledge. Low pressure aeration can categorize to be poorly managed-active aeration when clearly scientific clarifications are met. In case monitoring evidence is presented, country specific value or higher Tier can be used. Not only low-pressure aeration, knowledge on any kind of management related to active aeration are required to develop an appropriate methodology and parameter in the future .
786	5	3	87	87	Change "...SWDS(reducing..." to "...SWDS (reducing..." [I.e., add space after "SWDS"]	Jeffrey Coburn	Accepted	Corrected as suggested.
788	5	3	87	88	Change "… reducing energy use and savingcost of production." to "… reducing energy use and processing costs." This provides better parallel structure of terms. If you prefer "production costs", that is OK, but not really producing a product, so the term processing seems more appropriate. If keep current phrasing (not recommended) need a space between "saving" and "cost".	Jeffrey Coburn	Accepted	Corrected as suggested.
4646	5	3	88	88	"savingcost of production" should be correted to "saving cost of production" even if it is unclear which cost of production the text refers to	Ole-Kenneth Nielsen	Accepted	Corrected as suggested.
3424	5	3	88	90	You mention that low-pressure aeration projects have shown, that aerobic conversion of carbon is 25-75%, based on two demonstrations. These articles specify the composition of the gas extracted. From the ratio of CH4 and CO2 you can estimate the part of organic waste that decomposes aerobically (I think it can be calculated as (CO2-CH4)/(CO2+CH4)). However this is measured in the extracted gas and is only true for the part of the waste that is within the influence spheres of the gas wells. it is possible and maybe even highly likely (see PhD-thesis of van Turnhout), that using low-pressure aeration in large part of the waste anaerobic conditions remain, methane is generated and emitted. In such a case part of the methane is emitted through the top-surface and does not end up in the aerations off-gases. I do agree that the range of 25-75% is likely and when properly designed, even higher values can be expected. However there is insufficient R&D to come to such a conclusion.	Hans Oonk	Noted	Considering various comments recieved, this part has been removed. But authors agree that anaerobic zone would be remained by low-pressure aeration, and we need the further research and development. Authors have added the sentences regarding with it.
3426	5	3	88	90	The aerobic carbon conversion of 25-75% is based on two demonstrations of low-pressure aeration. Does this imply that the MCFs you propose only refer to low-presure aeration?	Hans Oonk	Accepted with modification	Considering various comments recieved, this part has been removed. MCF and the information in the Box is not corresponding. And MCF is not calculated from two references. That is just examples of minimum and maximum.
790	5	3	88	91	The sentence starting with "These projects have shown..." seems to have additional, redundant phrases at the start. I assume one study looked at (aerobic) decomposition of carbon and one looked at methane emissions, but it seems simpler to state this more directly. Recommend complete re-write of this sentence as follows: "These projects have shown that aerobic conversion of carbon in SWDS can reduce methane emission from 25% (Raga and Coussu, 2014) to 75% (Hrad et al., 2013), which corresponds to a MCF of 0.75 to 0.25, respectively."	Jeffrey Coburn	Accepted with modification	Considering various comments recieved, this part has been removed.
6206	5	3	90	90	The two literatures presented in line 79 in the FOD (lin e 90 in the SOD) have been changed, however still showing very large differences in respect to the reduction of methane emissions. Probably the literature (Raga ad Cossu, 2014) reflects only not well managed aeration sytems (see line 99 of the SOD) whereas Hrad et al reflects well managed aeration systems? In this case this information should be provided in line 90.	Christoph Lampert	Accepted with modification	This part has been removed by the comment from other reviewer. Authors understand this point and the information derived from these references are provided in table 3.1.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
3430	5	3	96	100	You need to realise that inventory compilers need to work with this refinement to estimate emissions from aerobic landfills. In the end inventory compilers need to be ble to justify the proportion of aerobic landfills that are wll managed. Reviewers need to be able to check whether this justification suffices. This process requires a clear definition of well managed and not well managed. If you are not able to provide such a clear definition, the refinement will cause a lot of discussions upon implementation and review. How can a country as e.g. Germany prove to a reviewer, that e.g. 90% of their aerobic landfills are well managed?	Hans Oonk	Noted	Difinition of the well-managed and poorly-managed SWDS is clearly given in table 3.1. In the countries that dispose the waste into SWDS with different type of management, such as Japan, survey on the ratio of each category of management is conducted and the results are reflected to their inventory.
792	5	3	96	96	Change "waste is SWDS" to "waste in SWDS"	Jeffrey Coburn	Accepted	Corrected as suggested.
3428	5	3	96	98	The best results of aerobic conversion of 50-75% … Where do the 50-75% come from? The only information gven are the aerobic conversions of Raga (25%) and Hrad (75%) Please provide a reference.	Hans Oonk	Accepted	These two references are just examples of minimum and maximum. Corresponding references are added as well as those given in table 3.1.
4648	5	3	97	97	"coversion" should be corrected to "conversion"	Ole-Kenneth Nielsen	Accepted	Corrected as suggested.
4172	5	3	97	98	Check spelling errors	Andrea Tilche	Accepted	Corrected as suggested.
794	5	3	98	99	Spacing, puncutation and grammar issues. Should read: "For active aration systems that are not well-managed, a default MCF of 0.7 was derived from the average of available literature…"	Jeffrey Coburn	Accepted	Corrected as suggested.
8886	5	5			In Table 5.3A, default CH4 emission factors for pyrolysis of waste vary a lot by different reactor types and operating temperatures. However, it can be challenging for countries/cities to find out such level of details about each of their waste incineration plants. Therfore it is recommended that IPCC also provides some default situation/emissions factors for each region/nation if it is not possible to determine which specific ones to use. It is also recommended that IPCC or UNFCCC requests country level research (or regular surveys) on current incineration technology deployment in each country.	Mingming Wang	Rejected	There are limited data of EF of pyrolysis and gasification, particulary on a commercial scale. To our current knowledge, Table 5.3 A in Final draft provide data of emission by processs and temperature. To this end emssion factor by region is not appropriate but country specific data (if availabel) can be used in higher Tier.
8888	5	5			It is known that uncontrolled burning of domestic waste is a common activity in many developing regions, and many cities do not have the facilities to carry out adequate collection and treatment of urban solid waste, so it is recommended that IPCC provides more guidance on estimating those emissions.	Mingming Wang	Noted	No action can be taken because comment is out of scope of 2019 Refinement.
3270	5	5	1008	1009	Verify bibliographic citation format of table 6A.3	Poot-Delgado Carlos Antonio	Noted	Not in Volume 5 content. Transferred to Volume 4.
1690	5	5	101	101	Edit "… non-condensible fractions which…"	Robert Lanza	Rejected	non-condensable' is right word, 'not non-condensible'.
1692	5	5	102	102	Edit "… by a quenching process. The gas products are composed mainly of volatile organic..."	Robert Lanza	Accepted	We have changed in line with the comment.
1694	5	5	104	104	Edit "… Solid products of the pyrolysis process include carbon-containing and inorganic components. The solid products may be burned for energy recovery within the pyrolysis process or transferred outside of the process for external energy or chemical feedstock or other use."	Robert Lanza	Accepted with modification	Solid poducts of the pyrolysis process include carbon residues (Char) and inorganic components. The solid products may be combusted in situ for energy recovery within pyrolysis process or transferred outside for external energy or chemcial feedstock use
1696	5	5	105	106	Edit "The gas products (pyrogas) may be recirculated back into the pyrolysis process to provide energy to the pyrolysis reactor, or the gas products may be transferred outside of the process for external energy or chemical feedstock use."	Robert Lanza	Accepted with modification	The gas products (Pyrogas) may be recirculated back into the pyrolysis reactor to provide energy to the pyrolysis reactor or transferred outside for external energy or chemical feedstock use.
3272	5	5	1053	1054	Verify bibliographic citation format of table 6A.4B	Poot-Delgado Carlos Antonio	Noted	Not in Volume 5 content. Transferred to Volume 4.
1700	5	5	106	107	Delete the sentence "Although CH4 is…"	Robert Lanza	Accepted	We have changed in line with the comment.
1698	5	5	106	109	Edit "… for external energy or chemical feedstock or other use. The energy-supplying system to the pyrolysis reactor is…"	Robert Lanza	Accepted	We have changed in line with the comment.
1702	5	5	109	109	delete "of organic wastes."	Robert Lanza	Accepted	We have changed in line with the comment.
4926	5	5	111	111	"estimated" should be completed by "and reported"?	Céline Gueguen	Accepted with modification	We have changed in line with comment 1704.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
1704	5	5	111	112	Add: Greenhouse gas emissions associated with use of gas, liquid, and solid products of the pyrolysis process that are transferred outside of the process for external use, whether used as fuel, chemical feedstock, or for other purposes, are reported at the point of use of the products, and are not reported as emissions from the pyrolysis process itself.	Robert Lanza	Accepted with modification	We have elaborated incorporating the sentence into the refinement.
3242	5	5	113	113	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Line 113 in Chapter 5 is the beginning of Box5.0B (New) not related to bibliographic formate
1706	5	5	116	117	Edit "… Depending upon reaction conditions, gasification of solid carbon-containing (organic) wastes are accounted for by four primary reactions."	Robert Lanza	Accepted	Depending upon reaction conditions, gasification of solid organic wastes are accounted for by four primary reactions.
3244	5	5	121	121	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Line 121 in Chapter 5 is the reaction of water gas reaction which is not related to biblographic format
1708	5	5	123	123	Edit "… These same four reactions would also describe processes for gasification of coal or coke, Greenhouse gas emissions from coal/coke gasification would be reported as an energy conversion process under Energy. [emission factors for coal gasification are not being provided in the Waste section of the guidelines)	Robert Lanza	Noted	Box5.0B explains gasification process which is in general. If gasification using coal and coke, this to be reported in energy sector. Pyrolysis and gasification of waste if used for energy purposes will be reported in Energy sector as well. We have clearly indicated in the chapter.
1710	5	5	123	123	Edit" The above gasification reactions reveal that the product gas primarily consists of H2, CO, and CH4, referred to as synthesis gas (syngas)."	Robert Lanza	Accepted	We have changed in line with the comment.
1712	5	5	127	127	Edit "… system following the gasified…"	Robert Lanza	Accepted	We have changed in line with the comment.
1714	5	5	128	128	Edit…" The clean syngas may be used as fuel…"	Robert Lanza	Accepted	We have changed in line with the comment.
1716	5	5	129	129	Edit "… or steam, or may be exported to another process or used as a chemical feedstock." [there are various other uses for syngas besides being combusted as fuel.]	Robert Lanza	Accepted	We have changed in line with the comment.
1718	5	5	131	131	Edit "… are know as tars, which…"	Robert Lanza	Accepted	We have changed in line with the comment.
1776	5	5	1318	1318	What is the definition of "aeration"? An ambiguous term.	Kazunori Minamikawa	Noted	This is not in chapter 5 of Volume 5. Transferred to Volume 4.
1720	5	5	132	132	Edit "… solid products consist of carbon and inorganic components."	Robert Lanza	Accepted with modification	We have changed in line with the comment; we use inorganic components and a little carbon residue.
1778	5	5	1326	1330	Would "Non-flooded pre-season >365 d" imply the upland-paddy rotation? Although not explicitly mentioned in the text.	Kazunori Minamikawa	Noted	Not in Volume 5 content. Transferred to Volume 4.
1780	5	5	1341	1352	Continuous parameter only for the amount of organic amendment (i.e., not for the decomposition rate of rice straw (1 vs. 0.19 even 1-day difference)).	Kazunori Minamikawa	Noted	Not in Volume 5 content. Transferred to Volume 4.
1722	5	5	135	136	Edit "… since syngas generated from gasification processes may be used for fuel, exported to another process, or used as a chemical feedstock, CH4 emissions are rarely expected from the gasification process itself (unless the syngas is vented directly to the atmosphere without being used for fuel or process purposes)." [edited to include the possibility of uncombusted/unprocessed syngas being vented directly to the atmosphere. This would be expected to be a rare occurrence.]	Robert Lanza	Accepted with modification	We have accomodated reviewer's comment and revised some parts.
1724	5	5	136	136	Edit "…Otherwise, the energy-supplying system to the gasification process is…"	Robert Lanza	Accepted with modification	Paragraph has been rewriten to address clearer understanding
1726	5	5	143	144	Edit "… Since plasma processes are operated…"	Robert Lanza	Accepted	We have changed in line with reviewer's comment.
1728	5	5	145	145	Edit "…nearly completely converted into clean syngas. Reaction residues of the plasma process consist of inorganic components including slag and metals." [syngas isn't always used as fuel.]	Robert Lanza	Accepted	We have changed in line with reviewer's comment.
1730	5	5	150	150	Edit "… since syngas generated from gasification processes may be used for fuel, exported to another process, or used as a chemical feedstock, CH4 emissions are rarely expected from the gasification process itself (unless the syngas is vented directly to the atmosphere without being used for fuel or process purposes)." [edited to include the possibility of uncombusted/unprocessed syngas being vented directly to the atmosphere. This would be expected to be a rare occurrence.]	Robert Lanza	Accepted with modification	We have totally revised the sentence to adopt comment 1730 but have not followed the reviewer's suggested sentence.
1732	5	5	151	151	Edit "…Otherwise, the energy-supplying system to the plasma process is…"	Robert Lanza	Accepted with modification	We have totally revised the sentence to adopt comment 1730 but have not followed the reviewer's suggested sentence.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
6198	5	5	172		On the Table 5.2 (updated), the description of note 3 “When waste is open-burned, refuse weight is reduced by approximately 49 to 67 percent (US-EPA, 1997, p.79)“ , related to old default oxidation factor, should be deleted.	Takefumi Oda	Accepted	Corrected as suggested.
1734	5	5	172	172	Note 6 -- The residue after open burning contains unburned carbon in the form of ash or other solid residue; the fate of the unburned carbon is to be tracked and the GHG emissions from the disposition of the unburned carbon is to be accounted for in the appropriate category (e,g., landfill).	Robert Lanza	Accepted	Corrected as suggested.
1736	5	5	172	172	Note 6 -- define "SWDS" acronym	Robert Lanza	Rejected	This is a common word in Volume 5 and has been elaborated earlier.
1738	5	5	172	172	Note 6 -- define "DOC" acronym	Robert Lanza	Rejected	This is a common word in Volume 5 and has been elaborated earlier.
1740	5	5	172	172	Table 5.2 -- suggest retitling the table "… CO2 emission factors from conventional incineration and open burning of waste" to indicate that emission factors for advanced processes e.g., plasma and gasification, are not included in this table.	Robert Lanza	Rejected	Title is to be in line with 2006 IPCC Guidelines.
1742	5	5	172	172	Has consideration been given to presenting conversion factors (conversion efficiency) for non-conventional waste management processes, e.g., gasification, plasma, in addition to the factors presented for conventional MSW incineration and open burning? Such factors wouuld be useful for inventory compilers assessing the amount of CH4 and CO and H2 produced from various processes, which could then be useful in combustion calculations for the Energy section of the inventory.	Robert Lanza	Noted	No action can be taken because comment is out of scope of 2019 Refinement.
6152	5	5	172	173	The oxidation factor of open-burning in Table 5.2 is 58% in the 2006 IPCC Guidelines. I assume that this value is obtained by the median of upper and lower end of refuse weight reduction rate mentioned in Note 3 of the table, i.e. (49%+67%)/2=58%. The orginal document is available at the USEPA website. According to Table 4-4 of the document, waste sample include fossil waste (e.g. plastics) as well as biomass waste (e.g. paper) and incombustible waste (e.g. metals). If the fraction is recalculated by excluding incombustible waste (glass/ceramics and metals), the fraction will become 71%. It is exactly the same as Yamada (2010) in the SOD. I believe the new oxidation factor is reliable.	Naofumi Kosaka	Accepted	Thank you for confirmation updated value.
4176	5	5	173	206	Section 5.4.2 presents methane emission factors for new technologies of pyrolysis and gasification. Emission factors for melting plants of MSW is presented in Table 5.3A, whereas emission factors from laboratory scale studies of pyrolysis and gasification are shown in Tables 5.3B and 5.4C, respectively. The values in Table 5.4A differ from those in Tables 5.3B and 5.4C by more than a factor of 1000. The text provides no guidance on which of these factors should be used. It is also unclear whether the laboratory scale emissions refer to methane produced or methane leaked from the system. This is a considerably need for clarification of which factors and which approaches should be used for assessing methane emissions from pyrolysis and gasification.	Andrea Tilche	Noted	Table 5.3B and 5.3C were supplied for information not for use as EF of pyrolysis and gasification plant on a commercial scale. Table 5.3B and 5.3C were deleted in the final draft to avoid confusion.
1744	5	5	174	176	Edit ".. . Although laboratory-scale data are available from scientific research literature for CH4 emissions from pyrolysis and gasification of solid wastes (new Box 5.2), very few data are available for commercial plants of these new technologies."	Robert Lanza	Accepted	We have deleted the table related to laboratory results. See also comment 4176.
3246	5	5	174	177	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Citation are in table 5.3A(New).
1746	5	5	177	177	Suggest that supporting text for New Table 5.3A should describe the mechanism(s) by which CH4 emissions arise from gasification/pyrolysis/melting processes, e.g., fugitive emissions of uncombusted / unpocesses synthesis gas, or other mechanisms.	Robert Lanza	Noted	CH_4 emissions from the stack of pyrolysis-melting and gasification-melting plant are made by incomplete oxidation of the product gases (eg. CH_4, C_2H_6, H_2, and CO) generated from operating the processes. This one is well described in the BOXs revised text.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
4930	5	5	183	183	Could you precise if the default CH4 EF proposed in the table 5.3A (new) correspond to EF for the destruction step (gasifier, pyrolysis reactor) or to the complete plants including the energy recovery system ? It is not clear for me as in the pyrolysis scheme you are presenting an "EXTERNAL" energy use of the pyro-gas and in the gasification scheme you are presenting that emissions are from the "energy recovery system". However, you are proposing an EF for both system. In order to increase transparency, you may add the "CO2, N2O, CH4" flow.	Céline Gueguen	Accepted with modification	We add one sentence in the revised text to answer the comments as follows: "The emissions of greenhouse gases from the combined system with energy recovery system are reported under the Energy Sector". In a broad sense, external energy supplying system is the same concept as the energy recovery system where heat and energy are recovered by heat exchange process. External energy supplying system combusts the product gases to supply the energy to reactor. In boxes related to pyrolysis and gasfication, we mentioned as "The external energy-supplying system to the gasifier is considered as the only emission source of greenhouse gases in the gasification plant. The emissions of greenhouse gases from the energy-supplying system within the gasification plant are reported under the Energy Sector" in the revised text.
1748	5	5	183	183	Previous statements (e.g., line 136, line 151, line 200) indicate that the energy-supplying system for the gasification/pryolysis process is the only source of GHG emissions from the process. If that is the case then the emission factors for CH4 in Table 5.3A should all be zero. Suggest editing line 136, line 151, line 200, and etc. to indicate that some CH4 emissions are anticipated to be emitted directly from the gasification/pyrolysis processes.	Robert Lanza	Accepted with modification	In case product gases from pyrolysis-melting and gasification-melting plant are used internally for the purpose of using as fuel to supply energy to system, some CH4 could be emitted as a result of its incomplete oxidation. The CH4 emissions from the internal use of product gases would be reported under Energy Sector not Waste Sector if pyrolysis and gasification process with energy recovery system. On the other hand, the product gases can be collected and transported to outside for using as fuels. In case of the external uses of product gases, the CH4 emission can be anticipated as a result of its incomplete combustion by external combustion facilities. The CH4 emissions would be reported under Energy Sector not Waste Sector.
1750	5	5	183	184	Suggest that supporting text for New Table 5.3A should describe the specific pyrolysis/gasification/melting processes that are described in the references Yoon (2016) and GIO (2017), potentially including process flow diagrams for each processe. This information would support the text discussion of the mecnahism(s) by which CH4 emissions arise from the gasification/pyrolysis/melting processes, e.g., fugitive emissions of uncombusted / unpocesses synthesis gas, or other mechanisms.	Robert Lanza	Noted	We have already described the generation mechanisms of CH_4 from pyrolysis and gasification in the boxes 5.0A and 5.0B. In addition Table 5.3A has been revised for better understanding.
1752	5	5	183	184	The table heading refers to "CH4 emission factors (g/kg pyrolyzed waste on a wet basis)" but only one of the two processes listed in the table is a pyrolysis process.	Robert Lanza	Accepted	We will change the table heading to : CH4 emission factors (g/kg on a wet basis).
1754	5	5	183	184	Reference GIO (2018) Page 7-34 indicates that " Different emission factor is used for each furnace type (shaft furnace, fluidized bed, and rotary kiln) for waste gasification/melting, based on (Reference #21) in the GIO (2018)	Robert Lanza	Accepted with modification	We have updated our information in line with the reviewer's comment.
1756	5	5	183	184	Reference #21 in GIO (2018) is "Survey Study on Improving the Accuracy of Emission Factors for Greenhouse Gas Emissions from the Waste Sector, 2010" Suggest accessing 2010 reference to assess availability of emission factors for shaft furnace, fluidized bed, and rotary kiln processes.	Robert Lanza	Accepted with modification	We have updated our information in line with the reviewer's comment.
1758	5	5	183	184	Reference Yoon (2016) title indicates that the subject matter of the reference is N2O emission factors, not CH4 emission factors, suggest clarifying	Robert Lanza	Accepted	The title of the table was wrong. So, we have changed the CH4 emission factor to N2O emission factor in the revised text.
1760	5	5	187	187	Edit "… Information on CH4 emissions…"	Robert Lanza	Rejected	We cannot understand reviewer's comment.
3248	5	5	193	194	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Box 5.2 (New) was revised and 3 references were quoted with standard format.
1762	5	5	193	194	Emission factors in Tables 5.3B and 5.3C are a factor of 10 E+04 higher than the emission factors in Table 5.3A (derived from commercial operating data cited in GIO 2018). Suggest providing rationale/criteria for when to use the emission factors in Table 5,3A and when to use the emission factors in Table 5.3B and 5.3C. laboratory scale data may not be representative of commercial operations	Robert Lanza	Noted	Table 5.3B and 5.3C were supplied for information not for use as EF of pyrolysis and gasification plant on a commercial scale. We consider dropping Table 5.3B and 5.3C to avoid confusion .
1764	5	5	199	199	Edit "… collected and may be used either as fuel or as chemical feedstock…"	Robert Lanza	Accepted with modification	We totally rewrote the box and decided to only explain the CH4 emission pattern in the box, not used for fuel and chemical feedstock.
1766	5	5	200	200	Line 200 indicates that CH4 emissions are not expected from pyrolysis processes. This statement (see also line 13 and line 151) seems to be inconsistent with the presentation of CH4 emission factors in Table 5.3A and particularly with the CH4 emission factors in in Tables 5.3B and 5.3C. Suggest that text be added to indicate when (under what criteria) the emission factors in Table 5.3A and Table 5.3B and Table 5.3C should be used.	Robert Lanza	Rejected	Box 5.2 (New) was revised. Even if the CH4 emissions would be negligible during the pyrolysis-melting and gasification-melting operation, those were measured from the stacks and can be used as CH4 EFs.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
1768	5	5	201	201	Suggest including a discussion here that the syngas may not be combusted at the same physical location at which it is produced, and that the CO2 and CH4 emissions from syngas combustion should be attributed to the specific Energy sector location in which the combustion takes place and not reported under "waste incineration" in the Waste sector of the inventory.	Robert Lanza	Noted	The Final draft explain clearly that the refinement provided information for CH4 and N2O emission from pyrolysis and gasification that is directly emit to atmosphere.
7170	5	5	226	226	" a few official data..." change to be "few official data..."	Luhui Yan	Noted	There are data for CH4 and N2O emission factor from new technologies.
1770	5	5	232	233	Reference GIO (2018) Page 7-34 indicates that " Different emission factor is used for each furnace type (shaft furnace, fluidized bed, and rotary kiln) for waste gasification/melting, based on (Reference #21) in the GIO (2018)	Robert Lanza	Accepted	We have updated our information in line with the reviewer's comment.
1772	5	5	232	233	Reference #21 in GIO (2018) is "Survey Study on Improving the Accuracy of Emission Factors for Greenhouse Gas Emissions from the Waste Sector, 2010" Suggest accessing the 2010 reference to assess the availability of separate emission factors for shaft furnace, fluidized bed, and rotary kiln processes.	Robert Lanza	Accepted	Same as comment 1756.
3250	5	5	260	261	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Rejected	260-261 is the references.
1782	5	5	3167	3198	Citation from a published paer is crucial to this report. Request review after the publication because we cannnot know the details of the annex 5a.2.	Kazunori Minamikawa	Noted	This comments is not with Volume 5 content. Transferred to Volume 4.
3252	5	5	387	435	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	
3254	5	5	438	439	Verify bibliographic citation format of table 6.3	Poot-Delgado Carlos Antonio	Noted	
3256	5	5	469	470	Verify bibliographic citation format of table 6.12	Poot-Delgado Carlos Antonio	Noted	
1652	5	5	48	48	Edit "…and have become important in…"	Robert Lanza	Accepted	We have changed in line with the reviewer's comment.
1654	5	5	50	50	Edit "… oxidation factors for the…"	Robert Lanza	Accepted	We have changed in line with the reviewer's comment.
1656	5	5	51	51	Edit "… based on experimental data, and including uncertainty."	Robert Lanza	Accepted	We have changed in line with the reviewer's comment.
3258	5	5	528	529	Verify bibliographic citation format of table 6.13	Poot-Delgado Carlos Antonio	Noted	
1658	5	5	53	53	Edit "… are generally combusted for use as fuel either on site or off site."	Robert Lanza	Accepted	We have changed in line with the reviewer's comment as follows: Since gas products containing CH4 and N2O produced by new technologies such as pyrolysis, gasification, and plasma processes are collected and used mostly as fuel or chemical feedstock, in situ CH4 and N2O emissions from the new technologies are expected to be quite low unless gas products containing CH4 is directly vented to the atmosphere. Greenhouse gas emissions resulting from the outside uses of gas, liquid, and solid products generated from new technologies are not reported as those from the new technologies themselves, but at the point of their use.
1660	5	5	54	54	Edit "… from the combustion of fuels derived from these new technologies are …" The text should make a distinction here between the reporting the [residual] CO2 emissions that would arise from the waste thermal treatment process itself and the CO2 emissions that would arise from combusting the fuel produced by the thermal treatment process. The fuel created by the waste thermal treatment process may be exported (e.g., CH4 fed into a natural gas pipeline) and burned off site, and in this case the CO2 emissions from the combustion of the fuel would be reported at the point of fuel use (e.g., the natural gas comsumer), not at the point of fuel generation (i.e., the waste thermal treatment process). Also, certain thermal treatment processes (e.g., pyrolysis) produce liquid products (aliphatic and aromatic hydrocarbons) that may not be burned for energy but rather may be used as chemical feedstocks or for other purposes. Thereby the total CO2 emssions from conventional incineration of the waste would be higher than the total CO2 emissions from thermal treatment (e.g., pyrolysis) of the waste, as some of the carbon content of the waste would be converted into liquid products for commerical use and not be converted directly into CO2 emissions from the thermal treatment process.	Robert Lanza	Accepted with modification	We have changed in line with the reviewer's comment as follows: Since gas products containing CH4 and N2O produced by new technologies such as pyrolysis, gasification, and plasma processes are collected and used mostly as fuel or chemical feedstock, in situ CH4 and N2O emissions from the new technologies are expected to be quite low unless gas products containing CH4 is directly vented to the atmosphere. Greenhouse gas emissions resulting from the outside uses of gas, liquid, and solid products generated from new technologies are not reported as those from the new technologies themselves, but at the point of their use.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
1662	5	5	56	56	Edit "… Incineration is defined in the …"	Robert Lanza	Rejected	We have deleted this sentence as a result of incorporating 2006 IPCC Guidelines.
3260	5	5	561	562	Verify bibliographic citation format of table 6.14	Poot-Delgado Carlos Antonio	Noted	
1664	5	5	58	58	Edit "… definitions of…"	Robert Lanza	Rejected	We have deleted this sentence as a result of incorporating 2006 IPCC Guidelines.
1666	5	5	60	60	Edit "… process that thermochemically converts…"	Robert Lanza		We have changed in line with the reviewer's comment.
1668	5	5	65	65	Edit "… is referred to as synthis gas (syngas) and is mainly used as fuel. Syngas may also be used as a feedstock for chemical production.	Robert Lanza	Accepted	Refer to comment '1764'
1670	5	5	67	67	Edit "… The highly reactive…"	Robert Lanza	Accepted	We have changed in line with the reviewer's comment.
1672	5	5	72	72	Edit "… plastics, and they are also used to treat MSW to avoid generation of air pollutants that would arise from conventional MSW incineration."	Robert Lanza	Accepted	We have changed in line with the reviewer's comment.
3262	5	5	744	745	Verify bibliographic citation format of table 6.17	Poot-Delgado Carlos Antonio	Noted	
1674	5	5	76	76	Edit "… are available for the…"	Robert Lanza	Accepted	We have changed in line with the reviewer's comment.
1676	5	5	80	80	Edit "… both with separate reporting of fossil and biogenic carbon dioxide emissions."	Robert Lanza	Rejected	This sentence was adopted from 2006 guideline
3264	5	5	846	847	Verify bibliographic citation format of table 6.18	Poot-Delgado Carlos Antonio	Noted	
1678	5	5	85	86	Edit "… collected and used either as fuel or as chemical feedstock…"	Robert Lanza	Rejected	Refer to comment 1764.
1680	5	5	87	87	Edit "… unless the CH4 produced by the thermal treatment process is directly emitted to the atmosphere without being captured for fuel or feedstock use."	Robert Lanza	Accepted with modification	We have changed as follows: Since gas products containing CH4 and N2O produced by new technologies such as pyrolysis, gasification, and plasma processes are collected and used mostly as fuel or chemical feedstock, in situ CH4 and N2O emissions from the new technologies are expected to be quite low unless gas products containing CH4 is directly vented to the atmosphere.
1682	5	5	87	88	Edit "… CH4 (and CO2, and N2O) emissions from combustion of the fuel produced by waste thermal treatment processes may be estimated using the emission factors in Volume 2.	Robert Lanza	Accepted with modification	We have changed as follows: Greenhouse gas emissions resulting from the outside uses of gas, liquid, and solid products generated from new technologies are not reported as those from the new technologies themselves, but at the point of their use.
1684	5	5	88	89	Edit "When the CH4 and other gas products generated by the thermal treatment process are not recovered for fuel or feedstock use, it is good practice to estimate both the CH4 and CO2 emissions from the thermal treatment process in the Waste sector." In the case of a waste thermal treatment technology that does not collect the syngas for use as fuel or feedstock, there would be both CH4 and CO2 emissions directly from the thermal treatment technology, as the syngas generally would contain both CH4 and CO2 (as well as CO and H2). If would be highly unusal to operate a thermal treatment syngas plant without actually collecting the syngas, but the inventory method should account for the possibility of the release of uncollected/uncombusted syngas from waste thermal treatment processes.	Robert Lanza	Accepted with modification	We have changed as follows: Greenhouse gas emissions resulting from the outside uses of gas, liquid, and solid products generated from new technologies are not reported as those from the new technologies themselves, but at the point of their use.
3266	5	5	915	946	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	
1686	5	5	92	92	Edit "… is a reductive and…"	Robert Lanza	Accepted	We have changed in line with the reviewer's comment.
1688	5	5	93	93	Edit "… molecular weight compounds…"	Robert Lanza	Accepted	We have changed in line with the reviewer's comment.
3268	5	5	951	952	Verify bibliographic citation format of table 6A.1	Poot-Delgado Carlos Antonio	Noted	
4928	5	5	96	96	"commingled" could be replaced by "mixed" ?	Céline Gueguen	Rejected	"Commingled" is common word used in waste field
7492	5	6			General comment: There will not be any updates to Table 6.5? Some of the values in the table are close to 20 years old which would motivate an update.	Klara Westing	Rejected	No action can be taken because comment is out of scope of 2019 Refinement.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
6228	5	6			General remark: For the methane emissions the number of literature justifying the introduction of this new source is very small. The new emission factors resp. MCF factors or emissions from aerobic waste water treatment systems shall be as robust as possible in order to avoid future adjustments of the MCF. The derivation of the MCF shall be included in the guideline (see also remark above line 22).	Christoph Lampert	Accepted with modification	The literature clearly identify that there are methane emissions associated with centralized aerobic treatment systems, and as such, it would be inappropriate to retain an emission factor of zero. An annex has been added to the document to present the derivation of the revised emission factor.
6230	5	6			Equation 6.10 (TOTAL NITROGEN IN DOMESTICWASTEWATER BY TREATMENT PATHWAY) and Table 6.13 (DEFAULT FACTORS FOR DOMESTIC WASTEWATER) shall be reconsidered as total N-flows most likely are significant overestimated (see also remark above in the lines 25 and 26).	Christoph Lampert	Rejected	"DEFAULT FACTORS FOR DOMESTIC WASTEWATER" is not Table 6.13 but Table 6.16. The authors disagree that total N-flows are significantly overestimated. However, we have updated this table to include geographic-based data obtained from FAOSTAT. In addition, inventory compilers can use country-specific data to calculate total nitrogen entering treatment plants, if such data exist for a Tier 2 or Tier 3 methodolodgy.
8890	5	6			Figure 6.1 only provides two types of treatment of sludge, which is not aligned with the sludge pathway given in Box 2.1A of Volume 2. Please clarify and consider making reference to the pathway given in Box 2.1A.	Mingming Wang	Accepted	Figure 6.1 has been updated and Box 2.1A has been removed.
8892	5	6			Figure 6.1a only provides a range of values for each country, which is not easy to use. Please also provide exact figures in a table format if possible.	Mingming Wang	Rejected	The detailed data are provided in "Annex 6A.1 Summary data for pit latrine use, no sanitation facility, and groundwater use by country"
3500	5	6	1037	1052	I am not an expert in N2O-emissions and as a non expert, I like this approach. I would like to refer to the additional information on N2O-emissions from WWTP in the PhD-thesis of Delré. In table 3 and 4 Delré presents information from literarture. The best interpretation of Delrés measurement is given in the supporting information of the article https://doi.org/10.1016/j.scitotenv.2017.06.177 (for copyright reasons, I can not give you this supporting information).	Hans Oonk	Noted	Thank you for your information. Unfortunately the recommended scientific paper reported GHG emissions including on-site sludge incineration. So these data cannot be included in our EF data source.
4184	5	6	1039	1051	Annex 6A.5 argues for different nitrous oxide emission factors for BNR and non-BNR. However, this difference relies on one single data point, which could be considered an outlier. The text does not include a statistical analysis of whether these emission factors are statistically significant. This would require some transformation of data, since the data is clearly not normal distributed. There is considerable reason to doubt whether there is data to substantiate a difference in emission factors between BNR and non-BNR.	Andrea Tilche	Accepted	We revisited outliers in the data, and decided to remove the data point addressed by the commenter. In addition, we have reviewed the difference in EF for BNR versus non-BNR systems and are now providing one N2O EF for centralized wastewater treatment plant.
4182	5	6	1048	1051	This text develops	Andrea Tilche	Noted	
3434	5	6	127	155	The overview of changes from the 2006 Guidelines to the 2019 refinement is incomplete. One change compared to the 2006 GL is removal of 'I' from the methodology. This is not mentioned, nor motivated in the SOD. Please mention this and motivate this change.	Hans Oonk	Rejected	The correction factor "I" has not been removed from the guidelines. It is now located in Equation 6.3A.
3436	5	6	127	155	Another important change compared to the 2006 GL are indirect emissions from discharge of TOW with the effluent of WWTP. Please include this in the overview of changes.	Hans Oonk	Accepted with modification	Changes compared to the 2006 Guidelines have been updated and are now located in Section 6.1.5.
3490	5	6	156	863	You encourage countries to quantify both CH4 and N2O emissions for separate pathways: direct discharge, non-BNR-WWTP; BNR-WWTP; septic tanks. Table 6.3 (EF CH4) and 6.15 (EF N2O) are in this version well synchonised. However tables 6.12 6.13 and 6.17 have different terminology. Where Table 6.3 and 6.15 use BNR and non-BNR, 6.12, 6.13 and 6.17 uses 'secondary' and 'tertiary'. Please use similar terms throughout, so BNR/non-BNR or secondary/tertiary. A definition of 'secondary' and 'tertiary' is only provided below 6.13 and 6.17. If you decide to keep this terminology, please introduce this definition as well below Table 6.12. Table 6.3 and 6.15 also include the effect of 'primary treatment' only. The pathway of 'only primary treatment' is no part of 6.3 and 6.15. If you think 'primary treatment only' is a relevant pathway to consider, please include EF for CH4 and N2O in 6.3 and 6.15 (so countries will collect activity data for this). If not, please remove this pathway from tables 6.12, 6.13 and 6.17. You might consider to combine all tables into one big table with overview of pathways, with CH4 and N2O-EF per pathway; C and N removal efficiencies, default sludge generation, etc.	Hans Oonk	Accepted	We have updated the text to ensure all terms are defined and that there is synchronicity between the tables.
6210	5	6	162	162	In the undermost box of Figure 6.1 on "Sludge treatment at Wastewater Treatment Plant" the treatment "aerobic stabilisation" shall be added as this treatment is typically used at small treatment plants	Christoph Lampert	Accepted	Figure has been updated.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
6212	5	6	177	179	It is said that there is insufficient data to quantify emissions directly from the sewer collection system, the emission factors presented for centralised treatment plants account for dissolved methane entering the treatment systems. How can the emission factors presented include these emissions as a quantification is not possible due to insufficient data?	Christoph Lampert	Rejected	There are insufficient data to reflect emissions that occur directly from collection systems as wastewater is collected and transferred to a centralized treatment plant. However, we recognize that emissions data used to develop EFs for centralized treatment plants include a contribution of dissolved CH4 that is being generated within the collection system and transferred to the treatment plant. Therefore, the treatment plant EF does include such
6214	5	6	192	195	There is also literature showing, that the major part of N2O-emissions stems from the denitrification step - the literature enclosed includes a broad overview on N2O emissions from sewage treatment plants.	Christoph Lampert	Accepted with modification	The sentence has been revised to say that both nitrification and denitrification are the important reaction for N2O emission.
3494	5	6	221	224	Definition of BNR. You need to realise that the methodology is used by people, performing inventories. Such a person has different topics to work with and is not necessarily an expert on waste water treatment. I guess > 95% of the processes you refer to are units for nitrification/denitrification, so you might include 'nitrification/denitrification' in your definition. Does it include others as well (e.g. Anammox?)? I am also confused by the 'and' in nitrogen and phosphorus. If a WWTP removes nitrogen, but not phosphorus, does is still qualify as BNR? My proposal would be: These “biological nutrient removal” (BNR) systems have unit-operations, dedicated to biological removal of nitrogen. In most cases, BNR will consists of zones for nitrification and denitrification, but other processes might also be relevant (e.g. Anammox). WWTP with BNR is often referred to be as part of 'tertiary treatment' or 'more stringent treatment (EU-UWWTD)'. In other definitions, BNR is considered part of secondary treatment.	Hans Oonk	Accepted	Text has been revised based on the comments.
3496	5	6	222	223	You write: ' which also results in higher potential for CH4 and N2O emissions.' BNR is demonstarted to result in higher N2O-emissions. Its impact on CH4-emissions is unclear and at the moment insufficient information is available to distinguish between CH4-EF for WWTP with BNR and without BNR. please adapt the text accordingly.	Hans Oonk	Accepted	Text has been revised based on the comments.
7172	5	6	234	234	"24h to 72hr" change to be "24hrs to 72hrs"?	Luhui Yan	Accepted with modification	The text has been updated.
7174	5	6	266	266	"CH4irrespective" change to be "CH4 irrespective"	Luhui Yan	Accepted	The text has been updated.
3438	5	6	269	269	The title of paragraph 6.1.1 should be 'Changes compared to the 2006 Guidelines'.	Hans Oonk	Rejected	This is incorrect. Section 6.1.1 of the SOD is related to the original section in the 2006 Guidelines, which compared the 2006 Guidelines to the 1996 Guideline and Good Practice Guidelines. There is no update to this section; however, for ease of reading, this section has now been moved to Section 6.1.4 and a new section (Section 6.1.5) has been added to discuss the changes of the 2019 Refinement related to the 2006 Guidelines.
3440	5	6	329	329	Third box at the left: 'Are measurements available'. This is not clear to me. What measurements do you refer to? Measurements of methane emissions from individual pathways? Or measurements of amount of TOW discharged via individual pathways. With regards to the latter, many countries have information available on TOW treated per WWTP (E.g. all EU-countries have information available per WWTP of PE treated per year, through monitoring of implementation of the UWWTD). If you want countries to use measured TOW per discharge pathway, before they start estimating TOW via a per capita default values, you should include this guidance in the text. please be aware that some countries will have statistics available on PE treated/removed; others may have measurements of COD or BOD available.	Hans Oonk	Accepted with modification	The decision trees for both methane and nitrous oxide have been updated to more clearly define Tier 1, Tier 2, and Tier 3 approaches. If a country has country-specific data on TOW or N discharged via individual pathways, they may use a Tier 3 approach to estimate emissions from treatment and/or discharge.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
6200	5	6	329, 564, 62		In the termination of the decision trees, there are a description of “Are activity data available to categorize discharge by type of waterbody**?** ” or “Are activity data available to categorize discharges to hypoxic environments?” when we use Tier 1a emission factors. 1) It is necessary to provide a guidance to categorize and collect activity data for each waterbody to which wastewater is discharged. 2) To elaborate adoption of the new EFs, it is necessary to develop an advanced methodology by using information of relationship between each source of wastewater and waterbody type to which wastewater is discharged. Please provide the realistic methodologies, If you have already prepared. 3) Related to the estimation of N2O emissions from discharged wastewater, Hypoxic environment is not always stable condition but can often irregularly appear/disappear/move in public water. Therefore, the severe adoption of such methodology is thought to be not easy. Providing current findings related to this matter is welcomed. 4) It is thought to be that adoption of EFs of Tier 1 (or average of Tier 1 and Tier 1a) is enough for all AD of non-key category. 5) **I t** is suggested that the decision tree is divided into those for “treatment” and “discharge” to elaborate selection of methodology to estimate emissions from discharged wastewater if the refinement focuses on the elaboration of emissions from wastewater discharge.	Takefumi Oda	Accepted with modification	We have revised our previous approach and have now provided additional guidance on the types of activity data which allow for receiving environments to be categorised as "nutrient-impacted" or otherwise. We have also provided guidance on the types of activity data and where to find existing data (including examples of existing databases online for some global regions) to help classify wastewater discharge receiving environments by type ("nutrient-impacted" or "non-impacted"). The methodology has also been revised to a Tier 3 method and provided with new guidance as above.
3442	5	6	334	335	The SOD reads 'For systems for which […] appropriate statistics are available it is good practice ….'. Note: the refinement gives guidance to calculate emissions on a national-level. For performing the calculation according to this SOD, national statistics are required on (i) amount of sludge generated and (ii) the way sludge is treated on-site (x% composting, y% anaerobic digestion, z% drying, etc.). Most countries will not have these statistics available. What guidance do you give when these statistics are not available. The 2006 Guidelines suggest that in such a case, S can be assumed to be 0. Does this still apply in the 2019-refinement? And if so, did you really solve the problem with possible negative emissions?	Hans Oonk	Rejected	The text has been revised to remove the reference to whether or not appropriate statistics are available; countries must estimate the amount (mass) of sludge they generate from wastewater treatment. Data are available for a number of countries in the Eurostate and OECD databases, and other country-specific databases, and Annex 2A.1 gives information on management of municipal solid waste. Using a default value of zero for "S" is no longer applicable.
3444	5	6	338	339	The SOD reads 'calculate emissions and any CH4 recovery directly associated'. The methodology in chapter 4 and the defaults in table 4.1 do not use nor produce data on CH4-recovery.	Hans Oonk	Accepted	Text was changed.
7480	5	6	340	340	Spelling error; "reports" should be "report"	Klara Westing	Accepted	The text has been updated.
4178	5	6	340	340	Change "reports" to "report"	Andrea Tilche	Accepted	The text has been updated.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
3446	5	6	349	349	In the SOD you propose to calculate indirect methane emissions due to discharge of effluent from WWTD to open waters. This might affect equation 6.1. TOW enters a WWTP/setic tank/etc and part of it is removed as sludge; part of it is discharged with the effluent. The remainder is biologically mineralised and the MCF describes what part of mineralisation takes place via anaerobic degradation (at least this is my understanding). For WWTP, only small part of TOW is discharged with the effluent, the the error here is small. But for septic tanks it becomes important: 50% of TOW is removed as sludge (when a septic tank is in compliance with the sludge removal instruction, see new equation 6.3A) and 50% of TOW ends up in the effluent (see New table 6.13). Still application of equation 6.1/table 6.3 results in 25% of TOW being emitted as methane. So in total 125% of TOW leaves the septic tank (either as sludge, with the effluent or as gas through mineralisation). You might rethink equation 6.1 to be something like "emissions = MCF *B0* (TOWinfluent - S - TOWeffluent)". Alternatively, for septic tanks, when sludge production is known and the TOW concentration in the effluent is known, methane emissions can be quantified from the mass balance (emissions = MCF *B0* (TOWinfluent - S - TOWeffluent), assuming that conversion of TOW to gas proceeds for 100% through anaerobic processes (so MCF=1).	Hans Oonk	Rejected	For septic systems, the MCF of 0.5 has been derived from literature measurement data (Leverenz et al, 2010; Diaz-Valbuena et al, 2011; Truhlar et al, 2016) accordingly with the default Bo, considering that the Activity Data is (TOW-S). So, changing the activity data would result in new MCF for septic systems and all other treatment/discharge pathways. Moreover, the total TOW leaving the septic tank is not 125%. For example, lets consider that 100 kg of TOW is entering the septic tank. With the application of the new Equation 6.3C, using the default F value of 0.5, the amount of TOW removed as sludge (Sseptic) is 25 kg, and therefore 75 kg remains in the tank. The MCF of 0.5 (derived from measurements and consistent with the activity data) means that 50% of the TOW remaining in the septic tank (37.5 kg) is subject to anaerobic decomposition and methanogenesis (NB. the MCF is not the same as the methane emission factor "EF" of Table 6.3 and applying the EF to this example does not produce a 25% methane yield from TOWseptic as the comment suggests, but rather closer to 10% of TOWseptic being emitted as methane once you apply the EF). A new Equation 6.3D was also added to allow the estimation of TOW discharged in septic tank effluent (TOW_EFF treat) which can then be applied in Equation 6.1 for CH4 emissions estimation from both the septic tank unit and discharged effluent.
6216	5	6	349	352	Our remarks on equation 6.1A (lines 259 to 261 in the FOD) have not been included. This equation seems to be incomplete if waste water is treated: (this is also true for the 2006 guideline): In a typical modern waste water treatment plant about 55% of the BOD ends up in the sludge and 10% is in the discharge. But: about 35% of the TOW is used up by the biomass and leaves the system as CO2 which is not included in the formula.	Christoph Lampert	Rejected	The EF is estimated as B_0 multiplied by the MCF. B_0 represents the theoretical maximum CH_4 that can be liberated from a type of waste, which by definition includes complete decomposition. The estimation of B_0 already includes the fact that a part of the organic load is emitted as CO_2 (see annex 6A.1). Carbon dioxide (CO2) emissions from wastewater are not considered in the IPCC Guidelines because these are generally derived from modern (biogenic) organic matter in human excreta or food waste of biogenic origin and should not be included in national total emissions.
3448	5	6	352	352	One of my main problems with the SOD is that methane collected from anaerobic digesters and methane from sludge production is treated differently. This implies that inventory compilers need to collect data on methane collection from WWT&D in a segregated way. Assume a case in which emissions from waste water ponds and sludge treatment are calculated seperately. Emissions from the waste water ponds are calculated using equation 6.1. R refers to methane recovered from the waste water ponds themselves (e.g. in case anaerobic treatment is part of the process) and is subtracted from gross emissions. Emissions from sludge are calculated using equation 4.1. R from sludge is included in the EF and is not subtracted from gross emissions. Countries will have problems to understand the correct way of calculating from the your guidance. If you decide to keep the calculation this way, I think you will need to describe this much more clearly in the 2019 refinement.	Hans Oonk	Noted	As wastewater treatment in ponds (anaerobically or aerobically) and sludge digestion are separate pathways, and if every pathway is calculated separately (including R, which in most cases is 0) as it is proposed in this refinement, there should not be a problem with emission estimation.
3450	5	6	352	352	Emissions from the waste water ponds are calculated using equation 6.1. R refers to methane recovered from the waste water ponds themselves (e.g. in case anaerobic treatment is part of the process) and is subtracted from gross emissions. Emissions from sludge are calculated using equation 4.1. R from sludge is included in the EF and is not subtracted from gross emissions. So the 2019 refinement requires more information on R, than the 2006 Guidelines: it requires information on a national level, what part of R comes from the waste water ponds and what part of R is due to anaerobic digestion of sludge (one is subtracted and the other one is not). What guidance do you give to countries, that do have information on total R, but not on R from water ponds and sludge treatment separately.	Hans Oonk	Rejected	The 2019 refinement does not require additional information. The methodology in chapter 6 allows estimatioin of emissions as in IPCC 2006 guidelines. Use of the Chapter 4 methodology is simpler as it does not need R, just amount of sludge undergoing anaerobic digestion.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
3452	5	6	352	352	Calculation of emissions via the 2019 refinement requires on a national level, what part of R comes from the waste water ponds and what part of R is due to anaerobic digestion of sludge (one is subtracted and the other one is not). The CRF-tables provide information, relevant for quantification of emissions. The current version of the CRF-tables only contain information on total methane flared and utilised (Table 5D, cell H10 and I10 for domestic waste water and cell H11 and I11 for industrial waste water). When your method of calculating emissions is accepted, the CRF-table 5D should be expanded and both methane collected at waste water ponds and sludge treatment should be reported separately.	Hans Oonk	Rejected	From the point of reporting (methane flared / utilised) there is no difference if the methane was captured from waste water treatment or from sludge digestion and there is no need to expand CRF Table 5D as suggested.
3454	5	6	352	352	Methane recovered from the waste water ponds is treated differently from methane recoverd during sludge treatment. One is included in the EF/MCF; the other one not. This will cause problems, which are avoided by treating R from both parts of the system the same way. My preference would be to include R in the EF/MCF, with EF/MCF for both parts describing emissions (generation-recovery), comparable to eq. 4.1. Additional advantage is that this approach is more accurate that the alternative, because propagation of errors is much less advantageous in the alternative. In this case R is still reported in the CRF-Tables 5D, but only for information purposes (comparable to R for anaerobic digestion of solid waste in Table 5B).	Hans Oonk	Rejected	Incorporation of R into EF/MCF is not possible in general guidelines. The range of technologies used is very wide and also option for capturing methane are wide. Such approach would result in a huge number of technology specific EF/MCF. However this approach could be used in a country-specific model.
3714	5	6	375	377	Please make clear that B0 is the theoretical methane generation, assuming all organic C to be convcerted to biogas. B0 is not the same as the biological methane potential, which excludes organic material, that does not degrade under anaerobic conditions. 'Improving' B0 can only be done by determining the average composition of TOW (CxHyOzNaSb) and calculate the theoretical amount and composition of its biogas upon complete conversion via the Busswell-equation. Refer to appendix 6A.3	Hans Oonk	Accepted with modification	Discussion in the text is revised to make clear that Bo represents the complete conversion of organic C to biogas. No country-specific calculation on domestic Bo is encouraged by the authors as that would also require an update to the MCF for each specific type of treatment system. A clarification has been added to mention that "Inventory compilers should compare country-specific **COD/BOD** ratio in domestic wastewater to IPCC default values of 2.4."
7484	5	6	375	381	The suggested default value of 0.6 kg CH4/kg BOD is totally unrealistic. As shown in Annex 6A.1 the theoretical value is 0.25 kg CH4/kg BOD removed. The figure 0.6 kg CH4/kg BOD is formed by multiplication of 0.25 with 2.4 which is a common ratio between COD and BOD in domestic wastewater. But with this operation all organic matter (measured as COD) is supposed to be degradable (normally measured as BOD, the part of COD that is readily degradable). Of course it could be stated that given enough time all organic matter will be degraded, but this takes at least several thousand years. It is probably not even true under anaerobic (methane producing) conditions, look at peat and crude oil.In the different listed systems in Table 6.3 the actual retention time is in most cases from 10 hours to one year. During this time it is very unlikely that more than BOD is degraded, giving methane. This means that the actual maximum methane formation is 0.25 x BOD. Using the factor 0.6 will overestimate the methane formation by at least the factor 2.4.The overestimation is probably even greater since the value of BOD is determined in aerobic systems. The actual anaerobic degradation is normally less than BOD. This is due to both the fact that more compounds are aerobically degradable than anaerobically, and to the presence of some oxygen, nitrate and sulphate in most wastewaters.If the factor 0.6 kg CH4/kg BOD is used to calculate the estimated methane formation from a certain amount of BOD this will lead to a great overestimation of methane emissions. We hope we have misunderstood the use of the factor 0.6 kg CH4/kg BOD. It is less embarrassing for us to be wrong, than it would be to have given totally wrong figures in the statistics.	Klara Westing	Rejected	The authors disagree that the default value for Bo is "totally unrealistic." Although one might argue there is an overestimation of the maximum methane generation capcitity (Bo in kg CH4/BOD) for some types of wastewater, it is a reasonable approximation for domestic wastewater, which contains a high percentage of biodegradable organic matter. In addition, the MCFs presented in this chapter are derived as the product of (measured emissions) / (Bo) using the default value of Bo. Therefore, any change to the default Bo value would trigger a need to reevaluate the default MCFs as well.
3456	5	6	387	388	Please make sure that the equations to be used for calculation of indirect emissions of methane due to disposal of treated waste water is covered by the general equation 6.1A, or include a seperate equation for indirect emissions of methane. If you don't include a clear equation, you might open up room for misunderstanding (note people can be very creative in misunderstanding things). In my interpretation, calculation of indirect methane from effluent of WWTP should calculated as a separate pathway. Equation 6.1A could be used, when TOWij refers to the TOW in the effluent of the waste water treatment plant/septic tanks and S is considered zero.	Hans Oonk	Accepted with modification	The emissions in question are no longer referred to as indirect emissions as in the 2006 Guidelines to avoid confusion with indirect emissions of N2O from deposition of nitrogen compounds. Direct emissions from discharge to aquatic environments are now captured in the final draft version of the Refinement (Equation 6.1A) for all discharge pathways.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
3458	5	6	387	388	For the effluent of WWTP I don't believe indirect emissions are a substantial source of methane. Assuming TOW removal to be about 90%, and your MCF of 0,035, emissions will be less than 10% of the emissions of the WWTP itself. Indirect emissions are important for e.g. septic tanks, where 50% of the TOW is discharged with the effluent. Please make clear that indirect emissions should be calculated for all discharge pathways.	Hans Oonk	Accepted with modification	The emissions in question are no longer referred to as indirect emissions as in the 2006 Guidelines to avoid confusion with indirect emissions of N2O from deposition of nitrogen compounds. Direct emissions from discharge to aquatic environments are now captured in the final draft version of the Refinement (Equation 6.1A) for all discharge pathways.
3460	5	6	388	390	The MCF will be affected by oxic conditions. You mention some literature indicating that methane might be generated under oxic conditions. However under oxic conditions MCF is unlikely to be as high as under anoxic conditions., due to competition of TOW-removal through other pathways (bacteriological aerobic degradation; consumption by higher lifeforms as fish, worms, water fleas, etc.).	Hans Oonk	Noted	No action is requested from this comment. We already have a factor 6 times higher when conditions are assumed to be more conducive to methanogenesis (benthic environments in lakes and reservoirs).
7482	5	6	389	389	Dishcarged BOD values are even lower for "new" processes such as the MBR process. It usually generates discharged concentrations of BOD < 2 mg/L. This is also common in well managed conventional activated sludge processes.	Klara Westing	Noted	No action is requested from this comment. The purpose of this test is to give general guidance that BOD is typically present in treated wastewater effluents. We cannot provide effluent BOD concentrations for every wastewater treatment technology type. Additoinally, MBRs globally are very uncommon (total treated wastewater volume in 2017 of ~12 GL/d; or ~4% of global sewered wastewater volume), so this makes it less relevant to provide such specific guidance in general introductory text.
6218	5	6	417	421	No arguments are given, why "well managed" and "not well managed" systems shall show the same MCF-value. However, especially the O2-concentration in the waste water strongly influences methan generation. The TOW (organics in the wastewater) does not reflect if a plant is overloaded. Maybe in some cases the relation between TOW an Smass (organic component removed as sludge) can give a hint of overloading.	Christoph Lampert	Accepted with modification	If a plant is overloaded, the removal of organic material as sludge will be reduced and should be reflected in the calculation of S in Equation 6.1 and Saerobic in Equation 6.3B. Therefore, compliers do NOT have to consider different emission factors for well managed versus not well managed since the amount of organics removed from overloaded systems will be reduced and will result in a higher amount of methane emissions compared to well managed systems. The text was revised to elaborate on this topic.
6220	5	6	438	438	For "Treated waste water treatment system" the derivation of the MCF (0,028) from the studies provided should be provided in the Annex. The number of literature provided for the MCF is still very low. The results obtained in the small number of literature provided show large differences. The production of Methane strongly depends on the temperature. The MCF presented in Table 6.3 relate to which temperature of the waste water (compare text in line 426 and 427 of the SOD)?	Christoph Lampert	Accepted with modification	The literature clearly identify that there are methane emissions associated with centralized aerobic treatment systems, and as such, it would be inappropriate to retain an emission factor of zero. An annex has been added to the document to present the derivation of the revised emission factor. Regarding the impact of temperature on methane emissions, the authors acknowledge that there is an impact of temperature on the MCF. However, there is insufficient data to derive temperature-dependent default EFs. In addition, reference documents rarely contain information on the temperature of the system and the authors want to emphasize the fact that the MCF relates with the temperature of the system and not with ambient temperature. In WWTP, additional heat can be provided to optimise the treatment system and in septic systems the tank is located in the ground and additional heat comes from hot water used in the household.
3462	5	6	438	438	For emissions from on-site sludge treatment (AD, composting, burning) is referred to chapter 4 and 5. In these chapters, emissions are calculated as W * EF, where W is the amount of waste entering the treatment. My interpretation of the second order draft is that emissions from sludge treatment should be calculated in a similar way as S*EF. Following this approach, S has to refer to the amount of raw sludge, coming the treatment ponds and entering the on-site sludge treatment, and not the amount of stabilised sludge that leaves the perimeter of the WWTP. This should be properly explained in the text, and the definition of S (line 357) should match this approach.	Hans Oonk	Accepted with modification	The variable "S" in Equation 6.1 refers to the organic component within sludge and has not been changed as suggested. The variable "Smass" in Equation 6.3B refers to the mass of sludge produced from wastewater treatment. Table 6.12 provides Krem value also for sludge from various types of treatment systems. The text has been updated to clarify this approach.
3464	5	6	438	438	For emissions from on-site sludge treatment (AD, composting, burning) is referred to chapter 4 and 5. Following this approach, emissions are calculated as S*EF, where S refers to the amount of raw sludge, coming the treatment ponds and entering the on-site sludge treatment. I think this is not a practical approach, since on a national scale no statistics will be available of the amount of raw sludge produced by the WWTP. Only stabilised sludge that leaves the perimeter will be recorded and reported. If you want to follow this apporach, you need to include a conversion factor, that allows inventory compilers to estimate raw sludge from stabilised and dried sludge as available from statistics.	Hans Oonk	Accepted with modification	See response to Comment 3462.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
3466	5	6	438	438	Most countries have no data on sludge generation from waste water treatment (the SOD acknowledges this in line 609). Only few countries may have sludge removal data. Your current aproach requires even more detail (amount of sludge removed per type of sludge treatment). What guidance do you supply for countries, that don't have this information available? I see three options: (i) you either allow them to neglegt S (in line with the methodology for N2O - see line 609); (ii) you encourage them to collect sludge data; (iii) you provide a default sludge generation per unit of TOW removed. If the methodology becomes dependent on availability of sludge generation data, guidance on methodology used should also be included in the decision tree in figure 6.2.	Hans Oonk	Accepted with modification	See response to Comment 3462.
3468	5	6	438	438	For sludge treatment, you give EF for composting, anaerobic digestion and incineration. However this overview is incomplete. Other sludge treatment options are: dewatering, thickening, drying (gas engines exhaust), spread-drying. My preference would be to simplify on-site sludge treatment and give seperate emission factors for (i) 'general sludge treatment' (when no information available on type of sludge treatment), 'anaerobic digestion' and 'other (non-anaerobic digestion)'.	Hans Oonk	Noted	The refinement has guidance on estimating emissions from anaerobic stabilisation. All other sludge treatment mentioned in the comment are considered to have negligible emissions - no emission factors. Engines used in operating WWT plant or sludge management are not reported under wastewater category.
3470	5	6	438	438	For emissions from sludge treatment, you propose to apply the defaults from the 2006 GL for biological treatment of solid waste. I think this is a major step back, for a few reasons (i) these defaults are based on only few measurements and (ii) AD or composting of solid waste is different from treatment of sludge. In line 113 in the SOD you state that "The refinements [...] provide new and improved defaut values and emission factors [...] based o further scientific research. For both composting and anaerobic digestion of solid waste much more information has become available (see the overview by Oonk, 2017, attached). Specific for emissions from waste water treatment plants (including anaerobic sludge digestion), recent emission measurements are performed by Daelmans, Delre and Ars (the latter two PhD-theses are included in another comment of mine). These publications do not directly give EF for sludge treatment, but can serve as a basis to quantify your EF.	Hans Oonk	Rejected	The calculation of emissions from sludge treatment should be consistent with the calculation of emissions from similar processes not located at a wastewater treatment plant; therefore, it is appropriate to reference the methodologies given in other chapters.
3472	5	6	438	438	You propose to use the emission factors in chapter 4. However moisture content of sludge and solid organic waste differs. So it makes a difference if you apply the emission factors for wet waste or dry waste. Which ones do you propose to use.	Hans Oonk	Accepted	All values are based on dry mass of sludge; therefore, values for dry waste should be used.
3474	5	6	438	438	In Table 6.3 in the SOD under anaerobic digestion of sludge, you indicate that CH4-recovery is not considered here. Maybe I misunderstand what you mean by this. However the default EF for anaerobic digestion in table 4.1 of the 2006 GL already accounts for already account for CH4 recovery (see note uder table 4.1). The EF refers to net emissions (difference between generation and recovery). Methane recovery is already considered in the default value and emissions should not be corrected by subtracting recovery once more.	Hans Oonk	Accepted	Text in table 6.3 changed.
3476	5	6	438	438	Under footnote 4) The publication of Kozak (Kozak, J.A., O'Connor, C., Granato, T., Kollias, L., Belluci, F. & Sturchio, N. (2009) Methane and nitrous oxide emissions from wastewater treatment plant processes. In: Proceedings of the Water Environment Federation, 1239 WEFTEC 2009, pp. 5347–5361) can not be found. It seems to be a conference publication and not a publication in e.g. a peer-reviewed journal. I personally do not believe that 'peer-review' is sufficient quality criterion (lots of good research does not make it to peer-reviewed publications, simply because they are performed by research organisation who do not focus on publication. And peer reviewed publications focus on new methodologies. Once a method is accepted standardised, its results are not published in peer reviewed journals). However an article needs to be accessible in order to be able to review it.	Hans Oonk	Accepted with modification	The reference noted by the commenter is available online through the Water Environment Federal or through https://doi.org/10.2175/193864709793952530. The reference list has been updated.
3482	5	6	438	438	There is no table 6.2. Does this mean that the table 6.2 in the 2006 Guidelines still applies?	Hans Oonk	Accepted with modification	Table 6.2 is still valid. The relevant portions of the 2006 methodology have been added to the 2019 Refinements document to make the guidance more clear to the reader.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
3484	5	6	438	438	In the last year, two new PhD-theses are published on greenhouse gas emissions from WWTP. Sébastien Ars and Antonio Delré (DTU, Denmark) performed measurements at several installations, using tracer-plume measurements. Delré included a review of available measurements in his thesis and expressed emissions as EF (kg CH4 per kg COD in the influent Table 1 page 11). His own measurements and the emission measurements of Ars et al are not included in this overview. The best interpretation of Delrés measurement is given in the supporting information of the article https://doi.org/10.1016/j.scitotenv.2017.06.177 (for copyright reasons, I can not give you this supporting information). Ars himself reports emissions and does not report EF. The names of the WWTP are given and the actual load in the year of measurement can be obtained. So the data from Ars can also be used to estimate EF. I took the effort and extracted the data from both theses in the spreadsheet attached.	Hans Oonk	Accepted with modification	Additional peer-reviewed and published data sources, including Delre 2017 and Noyola 2018, among others were reviewed and Delre 2017 was accepted for use in the development of the MCF for aerobic wastewater treatment systems. The text and supporting annex have been updated accordingly.
3486	5	6	438	438	It appears that your MCF for WWTP is for a large part based on Daelmans, who proposes exactly this EF of 0.007 kg methane per kg COD in the influent (so based on TOW as activity data). However Daelmans proposed this value as an overall EF for all activities of the WWTP (both the water ponds and the sludge-treatment) with COD in the influent as activity data (not TOW-S). Daelmans also concludes that most of the emissions are generated by sludge treatment, this value can not be used to justify an EF for only the water ponds with (TOW-S) as activity. More in general, you need to realise that emission measurements methods vary. Three types of measurements can be distinguished: spot-measurements (using floating boxes); plume measurements and in-duct measurements. The scope (the parts of the WWTP from which emissions are measured) is different for these measurements. Spot measurements measure emissions from the water ponds (not sludge treatment). Tracer-plume measurements (as used by Ars and Delré) give plant-integral emssions (water ponds and sludge treatment), with sometimes an opportunity to identify the different sources on the site (through dispersion modelling, when seperate plumes can be identified, see the PhD-thesis of Sebastien Ars). In-duct measurements (Dealmans, STOWA) allow only measurements of emissions in ventilated confined spaces and its scope depends on what unit operations are performed in such confined spaces.	Hans Oonk	Accepted with modification	The MCF for aerobic wastewater treatment systems is based on data collected from 15 different plants, as documented in 8 different data sources. Therefore, it is not accurate to say that the proposed MCF is based on Daelman. In addition, the MCFs were developed from the measured methane emissions data presented in the published literature, and taking into account the influent organics (TOW) and the amount of organics removed in sludge (S), consistent with the Tier 1 methodology proposed. Regarding the various methods for measuring emissions, please note that only data from plants where the wastewater emissions could be differentiated from sludge digester emissions were used in developing the MCF.
4656	5	6	438	439	Is it intentional that the same MCF values and EFs are listed for both 'Conventional activated sludge (non-BNR) processes' and 'Biological nutrient removal (BNR) processes'?	Ole-Kenneth Nielsen	Rejected	Yes. Two rows are presented in this table to be consistent with the similar table presenting N2O Efs. However, data were unavailable to differentiate Efs for these two types of systems.
3478	5	6	453	500	The SOD guides countries to quantify emissions from the water ponds and sludge treatment seperately. This only makes sense when this results in a more accurate quantification. I don't see the added value of this, compared to a simpler method estimating emissions from water ponds and sludge treatment combined, using an overall EF. If necessary you might distinguish between WWTP with anaerobic digestion of sludge and WWTP without. The complications of quantifying emissions from sludge treatment seperately are huge. To name a few (also addresed in individual comments): (i) most countries do not have data on sludge treatment available (you might provide default sludge generation). (ii) If they have data available, it will be data on stabilised sludge removed from the site and not sludge generated at the site (required as an input for the methodology for emissions from biological treatment of solid waste in 4.1, that you propose to use). So even when sludge data are available, a recalculation is required to get appropriate activity data. (iii) The EF for sludge treatment (chapter 4.1.) are outdated (based on few measurements) and measured for treatment of solid waste. Most emissions are from post-treatment of solid waste digestate and this is different from post-treatment of sludge-digestate. (iv) Recently more accurate emissin measurements are performed at WWTP with and without anaerobic digestion of sludge. Both Daelman and Delré proposes an overall EF for the total WWTP. The measurements might be used to improve EF from sludge treatment, but you will need to make assumptions to do so. The result will however be only an estimate of the actual EF for sludge treatment. So in conclusion, I don't see added value in estimating emissions from water ponds and sludge treatment seperately and large part of the problems mentioned might be solved by simplifying the methodology, allowing the use of an overall emission factor for WWTP.	Hans Oonk	Noted	The key reason for guiding countries to quantify emissions from WW and sludge separately is that combined estimation has led to negative emissions when countries have not properly estimated the methane generated by sludge. This refinement stresses the need to estimate emissions by pathways (including methane recovery, if any) to avoid this situation. If the methodology in Chapter 4 is used, estimation of emissions from anaerobic sludge treatment is simplified.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
3480	5	6	453	500	This paragraph in the SOD gives guidance to quantify the amount of TOW removed as sludge from the mass of sludge. I do miss the definition of sludge. From the context in this paragraph it appears that Smass refers to the amount of sludge, removed from the waste water treatment ponds, but before on-site treatment (composting, anaerobic digestion). The definition of Smass in line 498 provides no clarity, since it simply reads 'the amount of sludge removed from the waste water treatment'. Does it refer to raw sludge (coming from primary/secondary treatment) before on-site post-treatment. Or does it refer to stabilised sludge, leaving the perimeter of the WWTP?	Hans Oonk	Noted	It refers to raw sludge, and the text has been updated to reflect this. Table 6.12 allows recalculation of sludge (tons) to organics removed as sludge (BOD) for various types of sludge (e.g. if data on sludge are based on anaerobically stabilised sludge, Krem = 1). The definition of sludge is located in Section 2.3.2.
3492	5	6	470	470	Table 6.12 is not entirely clear. You need to keep in my the level of knowledge of people performing an inventory. My understanding is: (i) first line: raw sludge primary sedimentation refers to sedimentaion for WWTP with only primary treatment and sedimentation during primary treatment of more advanced WWTP. (ii) raw sludge from seconday treatment: sludge removed from secondary treatment, after primary treatment. (iii) the rest is obvious. My problem with the table is the following: line (ii) can be misread as sludge from non-BNR	Hans Oonk	Accepted	Table 6.12 was changed and text clarified.
3716	5	6	564	564	Please check, whether the decision tree makes sense. As I read it now, when measured COD-data are available, but no CS-EF, emission factors must be estimated, using a review of industry waste water treatment practices. I don't understand the last recommendation. What does it imply. Do you encourage countries to measure? And does the recommendation also apply when the amount of COD treated is that large, the the industrial waste water is no key category?	Hans Oonk	Accepted	We have revised the decision tree to clarify the three tiers related to emissions from treatment and emissions from discharge. We have also clarified in the text that countries that have COD or BOD measurement data (i.e., country-specific activity data) may use a Tier 2 method.
7486	5	6	609	609	Even though only a few countries have sludge removal data, all countries have some kind of sludge removal. I therefore find the default value of zero too low, even though we also find it difficult to quantify a specific default value.	Klara Westing	Accepted	The new approach presented in this refinement is not based on default S=0.
3488	5	6	623	623	Third box at the left: 'Are measurements available'. This is not clear to me. What measurements do you refer to? Measurements of nitrous oxide emissions from individual pathways? Or measurements of amount of N discharged via individual pathways? Some countries have statistics available on N in the influent/effluent of all WWTP.	Hans Oonk	Accepted	Decesion tree has been revised to make it clear.
6222	5	6	719	720	It is said: "Bath and laundry water can be expected to contribute an additional 10% to nitrogen loadings as well." What is the source of this additional 10%? If it is e.g. skin flakes, than this would be allready included in the protein consumption.	Christoph Lampert	Accepted with modification	More detailed explanation on the additional amount of nitrogen from household products and the method of emission estimation was added to the text.
6224	5	6	723	724	Same comment as in our remarks on the FOD: Table 6.13: the logic is not clear. If a default value of 0,85 for protein consumed is assumed (Line 717) the resulting TNDOM differs depending on the Basis of Protein activity data: e.g. activity data "protein available", in-sink disposal: 100 % protein * 1,1 = 110% e.g. activity data "protein consumed", in-sink disposal: 0,85 * 100 % protein * 1,25 = 106% But even more important: How is it possible, that finally more than 100% of the protein available ends up in the sewer system if there is no significant additional N-source in the households (in sink disposal). The same is true for Waste bin disposal: if the FAOSTAT data includes the available amount of protein, how is it possible that 100% of this protein ends up in the sewer system even some part of the protein is disposed of in waste bins (again, there is no signifiicant additional N-source)? The current equation 6.10 leads to a significant overestimation of the N-load in domestic waste water!	Christoph Lampert	Accepted	The section was reformulated, parameters were simplified, and method of emission estimation was adjusted. The data on protein available is related to food contributions only, and does not account for nitrogen contributions from other household products.
7488	5	6	742	742	Should NREM always be taken from Table 6.17, even if more country specific data is available? Please specify.	Klara Westing	Accepted with modification	This is a general comment that applies to all default factors for Tier 1 methodology provided in the 2019 Refinement second order draft and some additional guidance has now been added to the final draft to make clear that it is good practice for countries to use the default factors provided for Tier 1 assessments, but where country-specific data and factors are available, this can be used in higher order Tier 2 or Tier 3 assessments.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
6226	5	6	744	744	Table 6.17: in this new table the proposed default value for the N-removal for the treatment type "secondary (biological)" shall be reconsidered, as the value of an N removal of 40% is too high. Plants of this treatment type typically show an N-removal of 15-25%. This would mean, that also the lower value of the range on N-removal should be adjusted. Higher N-removals (e.g. 40%) can occur if uncontrolled processes of denitrification takes place, but this is not the typical case for these plants.	Christoph Lampert	Rejected	The numbers in Table 6.17 are taken from a combination of international literature as referenced in the table footnote and have also been cross-checked by Lead Authors with real plant performance data from local national wastewater treatment facilities. N removal rates for various secondary wastewater treatment processes including extended aeration activated sludge, lagoons, trickling filters and wetlands for Australian and New Zealand national performance data from 243 wastewater treatment plants are in the range of 55-90% (de Haas et al., 2018; https://doi.org/10.21139/wej.2018.023), so our current values for N removal in Table 6.17 are assumed valid.
7490	5	6	780	780	In New Figure 6.6, it might be a good idea to refer to Table 6.18 for examples of industries with large N2O emission potential.	Klara Westing	Accepted	A note is included in Figure 6.6.
3498	5	6	956	975	Amongst EU experts on waste, we had a discussion on the value of B0. I've been rethinking this topic, and I think the real discussion is about the meaning of the word 'theoretically' in line 958. I agree with B0=0.25 for COD, when "theoretically" means that all COD is assumed to be biodegradable under anaerobic conditions. So no biochemical limitations are assumed to exist and components, that are known to be not-biodegradable under anaerobic conditions (e.g. fibers, part of the bacterial biomass) are still assumed to degrade. Under this definition B0 is something else than the 'Biochemical methane potential' (BMP), which is the amount of methane generated from a sample under favourable, non-inhibited conditions. BMP excludes organic material, that does not biodegrade under anaerobic conditions. BMP can also be considered a theoretical methane potential, because in practice conversion of substrate to methane might be hindered by low temperatures, lack of nutrients, product inhibition (e.g. VFA), substrate morphology (larger substrates take more time to digest) and time. So B0 is something else than BMP: B0 is the theoretical methane potential, neglecting limitations to biodegradability of the substrate and BMP is the theoretical methane potential, taking into account limitations to the biodegradability of the substrate. I think this has impact on the guidelines: (i) I think this needs a bit more explanation in the text of Annex 6A.3, and you might change line 958 into: "The maximum CH4 producing potential, assuming no biochemical limitations exist for conversion of organic material into biogas, (B0) for domestic wastewater" and you might add a sentence "Please note that B0 is not the same as the biochemical methane potential (BMP), as determined in a lab-test, because BMP does take limitations to the biodegradability of the substrate into account". (ii) This is very important for the recommendation to develop CS-values of B0. It doesn't make much sense to develop a CS-value for B0, because it will be worldwide the same (organic material might be described as cellulose and this degrades as mentioned in line 960). If someone wants to improve B0, they have to determine the overal composition of TOW in waste water (CxHyOzSaNb) and apply the Busswell equation to determine B0. They should not base their CS-value of B0 on BMP-tests of waste water (because this will result in about 50% of the value of B0). (iii) The values of Bo for industrial waste water in New Table 6.14 are most likely based on BMP-tests and therefore somewhat lower than the B0=0.25 kg/g COD.	Hans Oonk	Accepted with modification	We accept the comments and have added a clarification in Annex A6.3 to emphasize that Bo is calculated considering total degradation of organic matter. In addition, although one might argue there is an overestimation of the maximum methane generation capcitity (Bo in kg CH4/BOD) of wastewater, the emission factors presented in this chapter are derived as the product of (Bo)x(MCF) and the values of MCF are based on results of actual emission measurements and the default value of Bo. Therefore, any change to the Bo value would trigger a need to reevaluate the default MCFs as well. Regarding the values on table 6.14, and upon further review of the data source, we have determined these values represent emission factors for specific industry wastewater treated in an anaerobic digester, and have removed them from the chapter.
4180	5	6	968	973	It is mentioned that the BOD/COD ratio is 2.4. This is wrong, since it is the COD/BOD ratio that is about 2.4. Throughout the text COD/BOD should be used instead of BOD/COD.	Andrea Tilche	Accepted	These changes have been made to the text.
2554	5	Annexes	2.24	2.28	In Annex 2A.2 (New): There are some countries for which waste composition is not given (e.g. Pakistan, Iran, Maldives), although there MSW generation and management data are given in Annex 2A.1/updated. Is it due to lack of relevant data?	Muhammad Mohsin Iqbal	Noted	It is difficult to fiind waste compostion data from the mentioned countries.
9036	5	3	191	192	"Unmanaged-deep (>5m waste) " in Table 3.1 (Updated) should be modified to "Unmanaged-deep(≧5m waste) " to reflect the annotation document No.6 in the table 3.1.	Ueda Hiroyuki	Rejected	This is to be in line with 2006 IPCC Guidelines.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors note
9038	5	5	232	233	Although N2O emission factor for gasification and melting (shaft furnace) in Japan's NIR (GIO 2017) is 19.3 gN2O/t waste, quoted emission factor in the table 5.4A is "15.5 gN2O/kg waste". Further, although GIO 2017 provides N2O emission factors for gasification fluidized bed type as 5.8 gN2O/t waste and gasification rotary type as 9.9 gN2O/t waste, these data are not quoted in the table 5.4A and much larger N2O emission factors of 0.829 and 12.0 gN2O/kg waste are quoted instead. Rationale for this intentional selection of N2O emission factors should be provided or values should be revised.	Ueda Hiroyuki	Accepted	We have updated our information in line with the reviewer's comment.