

In this document we provide our answers to ‘Anonymous Referee #2’ for “**Intercomparison of detection and quantification methods for methane emissions from the natural gas distribution network in Hamburg, Germany**”. We thank the referee for the comments which resulted in improvements of the manuscript. Please find our answers in normal blue text and changes in the manuscript in *blue italic-bold texts*.

The quantification of CH₄ emissions from gas leaks is highly important and an interesting dataset has been obtained using different methods. While parts of the manuscript are well written and also interesting conclusions have been drawn, other parts need major improvements. In my opinion, this paper can only be published after these improvements have been made and a reviewer (ideally from the inventory community) has seen the revised paper. The suggested improvements are mainly concerning the suction method and its implications on the inventories.

We thank the referee for the general comment. We had indeed discussed our results with experts who are directly involved in development of the emission inventory in Germany. We realized that there is lack of accessible information about the methods, assumptions and uncertainties. We reported the references based on our best knowledge and could not find clearer references. This is stated more clearly in the revised version of the manuscript.

1) Line 135-136: “The reported uncertainty range of this method is $\pm 10\%$ based on 23 measurements in the 1990s (E.ON, personal communication, 2020).”

This is only an appropriate reference if there is no published data about the uncertainty of the suction method. In this case, it should be stated that to your knowledge there are no publications about the uncertainty of the suction method. Otherwise, an appropriate reference should be used.

Despite intensive effort, we have not been able to retrieve a published reference for this statement, and therefore we need to report it as personal communication.

2) Line 518-524: “At several of the locations where the mobile method had indicated high emission rates subsurface accumulation was widespread, and the suction method was either not deployed or the measurements were incomplete because of either safety reasons or because the suction team estimated that they would be unable to complete the measurements within a day.”

I do not understand the requirement to complete the measurements within a day. If the aim of the study is to compare methods, the measurements should be completed even if it takes longer than a day. This constraint resulted in only one data point (fully completed measurement) for the suction method. In line 1002-1003 it is stated “While the mobile and tracer methods have been evaluated previously, this is the first peer-reviewed study that includes the suction method.” I doubt that one can state this given just one completed measurement. It could be justified if the partially completed sampling and its comparison to the other methods is discussed in more detail

Due to logistical and financial reasons the campaign period was limited to two weeks. To assess many different leaks, it was decided to stop the measurements after one day and report an upper leak rate estimate instead of a full quantitative estimate. Based on conversation

with the suction measurement team, the same practice applies when the suction method is used outside of this present study. We are of course fully aware of the consequences, and in our opinion, we discuss them clearly and openly. While we agree with the reviewer that “the measurements should be completed even if it takes longer than a day” to improve the accuracy of the suction measurements, the implementation in our study reflects the current practical reality and the consequences for reporting given the safety regulatory conditions. Regardless, we still consider this the first peer-reviewed study where the suction method was included, even when only one full quantification was derived; the upper estimates are also valuable.

Change in the statement:

While the mobile and tracer methods have been compared previously, this is the first peer-reviewed study that includes the suction method, although suction measurements could not be completed in one day at most locations.

3) Line 960-997 “4.4 Possible suction method sampling bias with implications for emission inventories”

After reading it the first time I became interested in the topic and started reading the referenced reports. After doing this, my conclusion is that 4.4. needs major revision.

You write in line 961-962 “The national inventory for CH₄ leakage from the gas distribution network in Germany is based on measurements with the suction technique (Umweltbundesamt, 2021).” I wanted to find out to which degree the inventory is based on the suction method and had a look at the referenced report. What I found is a reference to Gottwald et al., 2012 and Müller-Syring & Schutz, 2014. I had only a look at the latter reference and this only discusses theoretical emission estimates. It could be my fault that I missed the appropriate section in this extended report. However, it would be good to clarify what is meant with “based on” and it would be good to state where in this very extended report this can be found. (similar to what you do in line 966)

The statement is now rephrased as follows:

Following our communications with the emission inventory experts (personal communications with Christian Böttcher, 2022), we cannot fully reconstruct the methods that are used in the existing national inventory report to establish the emission factors due to lack of transparency. However, the German environmental agency (UBA) is considering to use the results of the recent large scale measurement campaign based on the suction method (MEEM, 2018) in future publications of the national emission inventory in Germany (Federal Environment Agency, 2021).

The next reference I was looking at was “MEEM 2022” (line 963). According to the reference section this is “MEEM, Analysing the Methods for Determination of Methane Emissions of the Gas Distribution Grid (2022). [online] Available from <https://www.dbi-gut.de/emissions.html>. (Last Accessed: 25 January 2022)” The link refers to a webpage of a project and the “MEEM Project - Phase I” has the title as given in the stated reference. I only found a “Management Summary GERG Project Phase I with the title Analysing the Methods for Determination of Methane Emissions of the Gas Distribution Grid” published in May 2016. The second phase under a different name has been completed in 2018. Therefore the reference

to the “ongoing project”, which is “underway to refine these emission estimates” needs to be updated.

The statement referring to the ongoing project is now removed.

Line 965-966: “This implies that this method is not applied at locations of the A1 category, which demand immediate repair (P. 27 in GERG, 2018).” Though the statement is correct in Annex 5 of the given reference it is stated “Three measurement principles are considered for direct measurements on underground pipelines: Tracer Method, Suction Method, High Flow Sampler”. Though I see that the suction method could “have a location sampling bias towards leaks in the B and C category”, I am not convinced that it is not accounted for this bias in the inventories by using other methods for the A1 and A2 categories.

To the best of our knowledge, gas utilities do not quantify gas leaks themselves and the quantifications are performed by a third party. Due to logistics and time required for a gas leak emission quantification from the third party, the quantifications are performed most likely only at the B and C locations for which repairs are not urgent. For the leaks reported by public (recognizable by the odor), larger emission factors are used, however it is not clear how large these emission factors are. For the A1 and A2 leaks during this campaign, we could not smell the odor, and detection was only based on the signals (CH_4 and C_2H_6) from the instruments.

In summary: I think this section is interesting but needs to be re-written. The references of the reports should be revised (correct year, link,...), Also, the reference GERG, 2018 and GERG 2020 are the same. In addition, it needs to be clearer what the suction method is used for and if this has really implications for the emission inventories or not.

References have been updated (changed to MEEM (2018)), and to the best of our knowledge (and the best knowledge of the NIR compilers that we contacted), the suction method has been used so far which is described in our manuscript. We believe that the implications for emission inventories are thus a logical interpretation as stated in this paper.

References:

MEEM, Methane emission estimation method for the gas distribution grid, [Online], Available from: https://www.dbi-gut.de/emissions.html?file=files/PDFs/Emissionen/Final%20Report_MEEM%20DSO_end_signed.pdf&cid=5804, (Last Accessed: 12 December 2022), 2018.

Federal Environment Agency: National Inventory Report for the German Greenhouse Gas Inventory 1990–2019, available at: <https://unfccc.int/documents/194930>, (last access: 15 December 2022), 2021.