

Technologies and Methodologies to Improve Methane Emission Reporting in Natural Gas Distribution Networks within the UNEP OGMP2.0 Reporting Framework

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Abstract

Methane emissions are the second anthropogenic source of greenhouse gases into the atmosphere; therefore, improving consistency in national emission inventories plays a pivotal role for the assessment of the global methane budget. Recent research projects on the Oil and Gas value chain have observed how national inventories are likely based on non up-to-date data and are not representatives of the true emission population, highlighting the need for more frequent and consistent measurements to ensure relevant sources are not missed, as well as to improve robustness in emission reporting to national and international authorities and gaining actionable insights for the design of new mitigation strategies across oil and gas companies.

In light of these considerations, in 2020 the UN Environment Programme (UNEP) International Methane Emission Observatory (IMEO) launched the Oil and Gas Methane Partnership 2.0 (OGMP), a voluntary-based partnership of international, non-governmental, and industry entities collaborating with research institutes to improve methane mitigation reporting through a mixture of direct measurements on point sources, detailed engineering calculations, and downwind measurement on different scales aiming to reconcile bottom-up inventories with top-down emission estimates.

Extensive experimental fieldwork has been deployed to address the bottom-up top-down reconciliation gap in the natural gas distribution segment of the supply-chain. Existing Leak Detection, Quantification and Repair data from the Italian distribution network are analyzed to map the main leaking components and causes of leakage. The aim is to identify the key Failure Modes of the system and their relative contribution to the total gas loss from leakage.

Subsequently, controlled release experiments in urban and industrial sites are carried out to make a performance assessment of mobile surveys for Advanced Mobile Leak Detection and Quantification. In the urban controlled release experiments, academic open-source and industry proprietary algorithms are tested for the purpose of leak detection and quantification accuracy; in the facility, single-blind controlled release experiments are used to evaluate the capability of downwind mobile surveys to triangulate emission sources. Then, emission rates are estimated using a Gaussian Plume Dispersion Model whose parameters are estimated directly from the methane mole fraction data instead of solely relying on atmospheric conditions. Results from the urban controlled release experiments show that all tested algorithms yields leak estimates positively correlated with the ground truth controlled emissions despite the challenging environmental conditions. Moreover, even if individual estimates are heavily affected by uncertainty, the average results of six different transects of the same plume are confirmed as a good trade-off between effort deployment and overall quantification accuracy, confirming the role of Advance Mobile Leak Detection of leak detection and quantification programs well as for leak repair prioritization by emission size.

Single-blind results from the industrial controlled release experiments show that the data-informed Gaussian Plume Dispersion Model yielded emission estimates within $\pm \sqrt{10}$ times for 17 out of 24 reported emissions events; the wind conditions appeared as the main limiting phenomenon, significantly compromising detection and triangulation source triangulation.

Finally, an extensive leak detection and quantification experimental fieldwork is deployed on national scale in Italy. Emission data are collected with a combination of Advanced Mobile Leak Detection and Quantification by means of a proprietary model, hand-held devices, and High Flow Sampling to build a large

dataset of leaks measured directly at component level and at site level. The resulting emission distributions are compared to identify possible discrepancies and verify if further insight can be drawn from the quantification with the High Flow Sampler. Our results show consistency in the mean emission rate estimates from both quantification methods and highlight the significant sampling effort needed to achieve the results.

In conclusion, this work aims contribute to the understanding of natural gas emission phenomena in the downstream segment of the value chain and to underline the potentialities and limitations of downwind measurement methods for reporting and mitigation practices and building a solid base for further policy making actions.