THE ROLE OF TECHNOLOGY INNOVATION IN EMISSIONS MITIGATION IN THE NATURAL GAS SECTOR

Arvind P. Ravikumar, Stanford University, Phone +1 650 736 3491, Email: arvindr@stanford.edu
Adam R. Brandt, Stanford University, Phone +1 650 724 8151, Email: abrandt@stanford.edu

Overview

The strong growth in renewable electricity generation in the U.S. and the rest of the world has been accompanied by a rise in the use of natural gas to complement wind and solar's intermittent nature. However, methane emissions from the upstream U.S. oil and gas sector threaten to erode the climate and health benefits of switching from a coal-powered to a gas- and renewable-powered world (Brandt 2014, 2016). Eliminating or reducing methane emissions from the natural gas supply chain is critical to sustainably meet global demand for liquefied natural gas (LNG). There is evidence that reducing methane emissions would be key to keeping global temperature increase below 1.5°C – an important milestone in the Paris Agreement (Collins 2018). Furthermore, research suggests that emissions of short-lived climate pollutants like methane contribute to thermal sea-level rise over time-scales far longer than their atmospheric lifetimes. Therefore, actions to limit methane emissions could mitigate centuries of future sea-level rise (Zickfeld 2017).

Recently, the governments of US and Canada have proposed regulation to reduce methane emissions form the oil and gas sector (U.S. EPA 2016). These regulators have taken the form of periodic leak detection and repair (LDAR) programs, primarily using optical gas imaging (OGI) based technologies (Ravikumar 2017a, Ravikumar 2018). We recently showed that an OGI-based LDAR program is likely to fall short of intended mitigation targets because of uncertainty in technology performance and operational characteristics (Ravikumar 2017b). Given the low spot prices and volatility of natural gas on the international markets, it is critical that proposed methane mitigation regulations are cost-effective. In this context, new technologies that promise cheaper, faster, and more accurate methane leak detection than conventional methods could reduce the barriers to industry-wide adoption.

In this work, we present the first results from the **Stanford/EDF Mobile Monitoring Challenge** that compared 11 different methane leak detection technologies and platforms. After this overview, we briefly discuss the methodologies and details of the two experimental sites used in the testing phase. Following this, we present the results from the technology intercomparison study and discuss its implications from a cost-effectiveness and emissions mitigation policy perspective. Finally, we summarize with an outlook for future methane mitigation regulations in the US and Canada.

Methods

Eleven leak detection technologies in this study were downselected based on technology readiness and deployment ability, from an application pool of over 25 technologies from 5 countries. These selected technology platforms include truck, drone, and plane-based monitoring systems. We conducted single-blind controlled methane releases over three weeks in March – May 2018 in two locations – the Methane Emissions Technology Evaluation Center (METEC) at Fort Collins, CO, and Rawhide Testing Grounds in Sacramento, CA. METEC is a Department of Energy funded controlled release facility that contains equipment typically found at a natural gas production site, and the Rawhide grounds were used to test large emission rates (> 100 standard cubic feet per hour, scfh). Through various timed test scenarios, four different technology parameters relevant to emissions mitigation were tested – (1) ability to detect leak location, (2) leak detection threshold, (3) time to detection, and (4) accuracy of leak quantification. In addition to these new technologies, we also included optical gas imaging (OGI) as a control technology. All results were analyzed indepently by the Stanford research team without any direct input from the participating technologies.

Based on the insights from the field experiments described above, we then use the Fugitive Emissions Abatement Simulation Toolkit or FEAST framework to evaluate the economics of various leak detection technologies and understand their role in a hypothetical regulatory framework (Kemp 2016). Here, we study two policy options: (1) policies with an absolute cut-off on methane emissions, either as a production normalized leak rate or emissions cap, and (2) presriptive policies similar to EPA's recent methane regualations (EPA 2016).

Results

Based on preliminary analysis of experimental results, we find that there is wide variation in performance even within similar technologies. For example, identifying leak location from drone-based technologies can range from specific component-level leak tag to a general facility level estimate. These variations are due to a combination of sensor properties and the data processing algorithms. Interestingly, we find that highly sensitive technologies are also prone to false positive detection rate up to 50%, which decreases with increasing leak detection threshold. In comparison, OGI based leak detection did not detect any false positives in the first round of testing. However, OGI technology could only detect leaks in the range of 5 – 10 scfh, compared to a threshold of about 1 scfh for some drone and truck-based technologies.

Using a FEAST based analysis, we found that the real-world marginal benefits of increasing detection sensitivity approaches zero. In the case of OGI based leak detection, a median detection limit of about 5 scfh is sufficient to capture the maximum amount of leakage possition through periodic LDAR surveys. Any sensor with a significantly lower detection threshold will likely not result in a proportionally higher emissions mitigaiton, while potentially increasing costs. Put differently, even a perfect leak detection technology (100% of all leaks detected) will not achieve 100% mitigation because of the stochastic nature of leaks. Increasing the detection sensitivity requirements can help reduce costs without compromising on mitigation targets. In this scenario, less sensitive but fast technologies including truck, drone, and plane-based platforms are attractive for future mitigation regualtions.

Conclusions

In general, we find that truck, drone, and plane-based technology perform better than conventional OGI based leak detection in at least one important parameter. While plane based systems are significantly faster and can be used to survey large areas, they can only detect the largest leaks at a facility. On the other hand, truck- and some drone-based systems have both high sensitivity as well as speed advantages compared to OGI based surveys, but can still be expensive when large areas need to be surveyed. The technology performance data gathered here would be vital to businesses evaluating new emissions mitigation measures at their facilities as well as for policy makers to develop more cost-effective regulations.

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