Vehicle-based methane mapping for leaks in natural gas distribution systems

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How can we cost-effectively reduce these emissions?

How can we find more of these leaks?
Laser-based methane analyzers

- Very high sensitivity & precision
- Sensor technology is “finished,” robust & reliable
- Picarro and ABB/LGR have sophisticated commercial surveyor systems (analyzer, GPS, wind, software)
Methane mapping science

GSV Car Instrumentation

Closed-path CH₄ analyzer
• 2Hz data = 15 feet @ 20mph
• Precision ±0.01ppm

GPS unit
• 24 inch precision

Each component reports performance data that were used in QAQC screening

Sample intake

Controlled release experiments

Allowed us to vary:
release rate: 2, 5, 10 & 40 L/min
Distance 5, 10, 20 and 40m

• Drive every road 2+ times
• Readings elevated if >10% above background.
• Data analytics for leak indication location & size

Von Fischer et al. (2017) ES&T
CSU Algorithm now openly available online

Weller et al. (2019) PLoS|One
CSU research publications

1) Description of methodology
von Fischer et al. EnvSci&Tech 2017

2) Incorporation into utility operations
Palacios et al. PublUtilFortn 2017

3) New stats method for estimating total leak count and emissions
Weller et al. Environmetrics 2018

4) Validation of false positives & leak size estimation
Weller et al. EnvSci&Tech 2018

5) Refinement of methodology, make code publicly available, downloadable
Weller et al. PLOS One 2019
EDF web site raises awareness about methane pollution

Search: *EDF methane maps*
<table>
<thead>
<tr>
<th>City</th>
<th>Miles surveyed</th>
<th>Leaks found</th>
<th>Leaks per mile</th>
<th>Total emissions (L/min)</th>
<th>Emissions per mile</th>
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</thead>
<tbody>
<tr>
<td>Birmingham, AL</td>
<td>345</td>
<td>168</td>
<td>0.49</td>
<td>592</td>
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<td>Boston, MA</td>
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<td>6,142</td>
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<td>Burlington, VT</td>
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<td><strong>SUM or MEAN</strong></td>
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<td><strong>0.54</strong></td>
<td><strong>16,262</strong></td>
<td><strong>1.5</strong></td>
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</tbody>
</table>

*Targeted mapping of corrosion prone parts of city
Wide range in leak frequency

Leak indications found per mile of roadway

*Targeted mapping of corrosion prone parts of city
Emissions from corrosion-prone pipe

\[ R^2 = 0.5697 \]

Emissions per mile of roadway

%Corrosion-prone pipe
depicted based on PHMSA data
15 cities, >6,000 leaks:
A few large leaks cause most emissions

Fraction of emissions cut vs. Fraction of leaks repaired

50% of emissions
From largest 16% of leaks

Palacios et al. (2017) PublUtlFort
CSU Leak indication study

- Two utilities: unable to find leaks at 83% of locations where we found elevated methane.
- We visited and “helped” search. Found 75% of our leak indications associated with leaks.
- The overlooked leaks included five Grade 1 leaks (11%), requiring immediate action.
- In these two cities, the false negative rate was 65%.
  - Actual number of leaks may be 2.6x higher than currently estimated.

Weller et al. (2018) ES&T
What causes these high false negative rates?

• Action threshold for [CH$_4$] is too low
• Leaks are inconsistent
• Crew training, diligence
• Policies that penalize utilities for leak counts rising

• *How can we improve policies, practices & technologies to find more leaks???
Main points

• Laser technology enables more sensitive & precise methane sensors for detecting natural gas leaks.

• Analysis of data yields rich information about leak size & location.

• Deployment in 15 cities shows wide range of leak frequencies, correlated with leak-prone pipe.

• Utilities claimed unable to find most leaks, until we worked alongside them.
  • Missed leaks included grade 1 and buildings filled with gas

• Detection technology is not “beta” stage:
  • Publications
  • CA SB1371
  • Commercial success
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