Role of Technology Innovation in Emissions Mitigation in the Oil & Gas Sector

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Introduction – Methane Emissions

• Methane emissions from oil and gas activity is a significant source of GHG emissions in US and Canada

• Reducing methane has multiple co-benefits, in addition to climate impact
  • Improve air quality (precursor to low-level ozone)
  • Reduce product waste
  • Social license to operate near population centers

• Recent studies show significant higher emissions compared to EPA GHGI
  • 2.3% (Brandt et al. 2018) vs. 1.7% (GHG Inventory)
  • Significant upward revision in upstream production – 7.6 vs. 3.5 Tg/y
  • Aggregation of facility-level estimates
Policy Approaches to Emissions Mitigation

• Most active jurisdictions (CO, Canada) have prescriptive policies
  • *Venting and Flaring:* Annual limits verified through activity data and production figures
  • *Fugitive Emissions:* Periodic leak detection and repair (LDAR) surveys

• Managing fugitive emissions or leaks
  • LDAR survey typically conducted with infrared camera technology
  • Survey frequency varies from 1/year to 12/year

• Drawbacks of camera-based surveys
  • Component-level measurements are time consuming
  • Highly susceptible to weather conditions
New Technologies and Platforms

• Truck-, drone-, and plane-based detection systems have been developed
  • Truck- and plane-based pilot studies reported in literature

• Strong business and investor interest in testing new technologies

• Potential to provide more cost-effective mitigation
  • Colorado and Alberta actively studying ways to incorporate new tech
Design Space for New Technology

‘Fast screening’

Temporal Scale (s)

Spatial Scale (m)

10^{-2} 10^0 10^2 10^4 10^6 10^8

Component facility field basin continent global

Continuous monitoring Inventories, trends

Stationary sensors (e.g., LIDAR)

Handheld monitors (e.g., cameras)

UAVs

Piloted aircraft

Satellites

Mobile Ground Labs (Trucks)

Mitigation Programs

Revisit time ~ 1 week

~45 min flying time

Fox et al. In review (2018)
Key Problem – Demonstrating Equivalence

• Need to demonstrate mitigation achieved using new technologies will be equivalent to existing approaches
  • Depends on how effective existing camera-based surveys are

• Recent work – controlled release experiments with cameras at METEC
  • OGI leak detection limits 10x higher than prior lab estimates

• More recent field-work with truck-based measurements in US & Canada
  • Provided facility-level instead of component-level data, but
  • Limited ‘ground truth’ measurements → direct comparisons difficult

Ravikumar et al. EST (2018)
Defining Equivalence

• **Technology-specific parametrization**
  
  • Minimum detection threshold, speed, false positive rate, etc.
  
  • Can be identified by blind-tests (MONITOR program, Stanford/EDF Mobile Monitoring Challenge)
  
  • But mitigation effectiveness unclear

• **Performance-based parametrization**
  
  • Technology + Protocols
  
  • Mitigation potential based equivalence – reduces uncertainty
  
  • But cannot be easily experimentally verified
Stanford/EDF Mobile Monitoring Challenge

- Test mobile approaches to leak detection
- Platforms – drones, trucks, and planes
- 28 applications received for the MMC call
  - 5 countries – US, Canada, Netherlands, UK, and Mexico
  - 12 technologies; 10 ultimately participated

Visit: methane.stanford.edu
Example Technology Testing
Results – Technology A (Drone)

- Best-in-class performance (detection & quantification)
- Professionally managed operations (standard operating procedures)
- Real time data including quantification (initial estimate)

Leak identification (overall)

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<th></th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
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<tbody>
<tr>
<td><strong>Total number of leaks</strong></td>
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<td>False -</td>
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<td><strong>No Leak</strong></td>
<td>True +</td>
<td>True -</td>
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- **Locational Accuracy**

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<tbody>
<tr>
<td><strong>Total number of leaks</strong></td>
<td>63</td>
<td></td>
</tr>
<tr>
<td><strong>Number detected</strong></td>
<td>59</td>
<td></td>
</tr>
<tr>
<td><strong>Number location identified</strong></td>
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</tr>
<tr>
<td><strong>% location identified correctly</strong></td>
<td><strong>0.85</strong></td>
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Technology A - Quantification

- Most leak estimates within 2x of actual leak rates
- (Quantification, in general, is very difficult. Within 2x is exceptional performance for sensors that don’t directly measure flow rates)
Technology B – Detection (Drone)

- High false positive rate (> 70%)
- Professional conduct in field (operations)
- Real time data on detection but not quantification

Leak identification (overall)

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Locational Accuracy

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<th>Total number of leaks</th>
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<tbody>
<tr>
<td>Number detected</td>
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<td>Number location identified</td>
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<tr>
<td>% location identified correctly</td>
<td><strong>0.49</strong></td>
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Technology B – Leak Detection Probability

- Leak detection probability proxy by histogram of leaks detected within a given range
- Median threshold ~ 2 scfh with high false positive rate (Note: company specified ‘definite detection’ is 6 scfh)
Bringing Policy Makers, Industry, and Academia Together

- Workshop to develop future mitigation frameworks for regulators
- Invite-only workshop with academics, regulatory agencies, and industry
  - Environment Canada, Alberta Energy Regulator
  - U.S. EPA, Colorado DPHE, California ARB
Field Campaign to Assess Policy Effectiveness

- 50 x 50 km area NW of Calgary
- ~ 200 sites selected for leak detection and repair surveys
- 3 survey schedules (1, 2 or 3 times/year) and 1 control group
- Goals: Determine time evolution of emissions mitigation – ‘sunset policy’
Future Work and Conclusions

• New technologies are promising alternatives for cost-effective methane emissions detection, but...

  • Technologies should be parametrized through well-designed control studies and pilot demonstrations
  • Couple data with models to estimate ‘equivalent’ emissions reductions and analyze long-term impact

• Policy design should allow for flexibility in mitigation practices
  • Allow for the use of ‘screening’ technologies
  • Re-think survey frequency rules as applicable to new technology