ADED - Advancing Development of Emission Detection

DE-FE0031873

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Prime: CSU
PI - Daniel Zimmerle
Project Manager – Kristine Bennett
Lead Scientist - Clay Bell

Subawards:
Harrisburg University – Arvind Ravikumar
University of Texas, Austin – David Allen
University of Texas, Arlington – Kathleen Smits
Agenda

• Technical Status
  • What are next generation leak detection solutions
  • How will ADED accelerate adoption of those solutions
• Accomplishments to Date
• Lessons Learned
• Summary

https://energy.colostate.edu/metec/aded/
Technical Status
Next Generation Leak Detection Solutions

• Why?
  • Potentially faster, lower cost, and more effective than traditional leak surveys
  • Enabled by development of new, lower-cost sensors, communications and computational systems

• What:

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Deployment</th>
<th>Analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration</td>
<td>Moving/stationary</td>
<td>Data acquisition, time</td>
</tr>
<tr>
<td>Line-concentration</td>
<td># of sensors</td>
<td>series analysis,</td>
</tr>
<tr>
<td>Imaging, acoustic, etc.</td>
<td>Frequency of deployment, etc.</td>
<td>machine learning, etc.</td>
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• In general – deployed more often, or more continuously, than traditional methods
Need for “To Protocol” Assessment

Controlled Testing (METEC)
- Protocol
- Testing
- Performance Metrics

Field Testing (Pilot Sites)
- Protocol
- Testing
- Performance Metrics

LDAR Simulation Tool (PtE)
- Emissions Simulation
- LDAR Simulation
- Program Simulation

No intermittent emissions
Tests with emissions
Winds 0-9 m/s
Amb. Temp 0-35 C
30 points per bin
Taxonomy of Solutions

All Solutions
Detect emissions, identify approximate leak locations, possibly quantify

“Continuous” Monitors
Stationary, installed on site, semi-autonomous, no operator

Survey Solutions
Mobile, deployed periodically, with operator, detect, quantify, localize

Screening Solutions
Mobile, deployed periodically, identify possible emissions without localization or quantification

Facility

Remote Sensing
Aircraft, Satellites,

Separately funded extension will extend survey protocol for aircraft.

Pipelines
(add PHMSA-funded effort)

Included in ADED

Facility

Component
Current regulatory approach

Remote Sensing
Aircraft, Satellites,

Pipelines
(add PHMSA-funded effort)
Why Both Controlled & Field Testing

Controlled testing: No confusion about the ‘true state’ of the facility being screened

• Determine key parameters to evaluate effectiveness (i.e. “detection curve”)
  • Classify reported detections: True positives vs false positives
  • Identification of false negatives (non-detects)
  • Determination of “time to detect”

Field testing: More realistic ... but incomplete knowledge of ‘true state’ of facility

• More realistic environment to test actual deployed behavior
• Testing control is much more difficult
  • No ability to track everything that happens at the site ... no foolproof 24/7 monitoring
  • Slow quantification (relative to solutions) with substantial uncertainty
  • Difficult to test efficiently – i.e. encounter a large number of emitters during testing

Controlled testing characterizes the solution ... field testing qualifies the controlled testing protocol
What does Controlled Testing Produce?

- Probability of Detection (PoD) curve
  - More robust representation of detection than MDL or LDL
  - Required input for emissions modeling for regulatory or responsible gas programs
- Protocols also support evaluation of quantification capabilities

Number of independent variables drives number of required tests
- Always 1, possibly 2, independent variables
- More variables requires many more tests
**Associated Projects**

- **Advancing Development of Emissions Detection (ADED)**
  - Prime: CSU
  - Co-Investigators: UT Austin, UT Arlington, Harrisburg U.
  - Funding: U.S. Department of Energy & Operators

- **Methane Emission Estimation Toolkit (MEET)**
  - Prime: UT Austin
  - Co-Investigators: CSU, SLR
  - Funding: CAMS

- **Pathway to Equivalency (PtE)**
  - Prime: CSU
  - Co-Investigators: Harrisburg U.
  - Funding: Operators & EDF

- **Simulate Method Performance**

- **Emissions Mitigation or Control Efficacy**

- **Open Process To Engage All Stakeholders**
Accomplishments to Date:
BP1 Complete 9/15/21
Controlled Testing

• Protocol Development Committee (PDC)
  • Participation of over 75 stakeholder organizations
• Initial protocols developed & utilized in testing
  • Continuous Monitoring
  • Survey Systems
• Testing conducted
  • Continuous Monitoring – 4 Solutions
  • Survey Systems – 4 Solutions
Field Trial

• More operator participation than anticipated
  • 15 operators engaged in field trial
  • Denver Julesburg (DJ), CO
  • Marcellus/Utica, WV/OH/PA
  • Permian, TX
  • Green River, WY

• Over 30 LDAQ solutions currently being considered for field trial.

• Field trial plan will be submitted prior to end of budget period.
Broader Project Impacts

• Protocols influencing external controlled testing
  • Drafting appendix to survey protocol for application with remote sensing aircraft.
  • Stanford planning major field work utilizing this protocol for multiple aircraft.
  • CSU to conduct testing of 1 aircraft solution under protocol in Midland TX.

• Two additional proposals (1 submitted, 1 drafted) to adapt protocols for other external test programs.

• Protocols referenced by a “responsibly produced gas” standard
Lessons Learned
COVID-19 Pandemic Impacts

→ Travel restrictions complicated logistics for controlled testing
  • Adapted testing program to support “rolling window” CM testing → substantial increase in labor required to support
  • More test periods with fewer solutions per period

→ Field trial delayed due to travel restrictions and company policies.
  • Proceeding as planned
  • Increase in US Covid cases could impact scheduling further
Other Learnings

→ Greater operator interest in field trials than anticipated
  • Modify plan to include more basins and operators
  • Quarterly field tests, moving between basins
  • More variability in number & identity of solutions deployed each quarter

→ Solution developers vary in acceptance of controlled testing
  • Some are ‘selling services’ and do not see ‘being evaluated’ as a necessarily positive
  • O&G operators are putting pressure on solution developers to test ... but are not yet withholding purchasing.
Accommodating 15 operators and 10+ solutions:

- Per region:
  - Tentative Field Locations:
    - Marcellus/Utica (PA/WV/OH)
    - Green River (WY)
    - Permian (TX)
    - DJ (CO)
    - + Stations/Storage sites in CA

- Total field trial:
  - Continuous Monitor Deployment
  - Survey Solution Deployment
  - Study Team Deployment
  - 2 Wks
  - 12 - 16 Wks
  - ≈12 Months
Synergy Opportunities

Measurement projects:
- Better data to characterize emissions
- Better understanding of focus for leak detection solutions

Characterize Emissions

Characterize Methods
- Field Trials
- Controlled Testing

Simulate LDAR Method Performance

Emissions Mitigation or Control Efficacy

Compare other leak mitigation methods to LDAR programs

Simulate Another Type of Mitigation Intervention

- Better understanding of focus for leak detection solutions
Project Summary

• There is substantially more interest in next-generation leak detection solutions than when the project was proposed.
• Broad buy-in to the protocols and approach
• A much more flexible testing program was needed to adapt to Covid and on-the-ground realities (and enthusiasm)
• A more diverse (regional and industry segment) testing program is now possible ... and will produce better results.
Thank You
Appendix
Program Benefit

• Accelerate the adoption of next-generation leak detection solutions, lowering the cost and increasing the efficacy of leak detection of industry, regulators and general public.
## Project Objectives

<table>
<thead>
<tr>
<th>Success Criteria</th>
<th>Budget Period</th>
<th>Decision Point</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>Five (5) LDAQ solutions identified and committed to testing during first year of controlled testing.</td>
<td>BP 1</td>
<td>Go/No-Go to Begin Field Trial</td>
<td>Eight (8) LDAQ solutions tested during first year of controlled testing.</td>
</tr>
<tr>
<td>A minimum of one (1) field trial site used for testing in each of production, gathering and distribution sectors.</td>
<td>BP 1</td>
<td>Go/No-Go to Begin Field Trial</td>
<td>15 operators participating in field trial including at least one each in production, gathering, and distribution sectors</td>
</tr>
<tr>
<td>Protocol revisions completed as defined in the SOPO and reviewed by the Protocol Development Committee.</td>
<td>BP 1 &amp; 2</td>
<td>Go/No-Go to Continue Field Trial</td>
<td>Initial protocols developed and reviewed by Protocol development committee (PDC)</td>
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<tr>
<td>Three (3) protocol development workshops/teleconferences conducted with 30 or more attendees at each.</td>
<td>BP 1 &amp; 2</td>
<td>Go/No-Go to Continue Field Trial</td>
<td>Protocol development committee (PDC) includes &gt;75 participating organizations at end of BP1. One (1) virtual PDC meeting hosted for initial protocols.</td>
</tr>
<tr>
<td>Equivalency simulations completed for &gt;80% of LDAQ solution tested in the field trial (some may drop out).</td>
<td>BP 3</td>
<td>End of Project</td>
<td></td>
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<tr>
<td>Two (2) peer-reviewed publications submitted.</td>
<td>BP 3</td>
<td>End of Project</td>
<td></td>
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<tr>
<td>Protocols and test results presented at &gt;5 industry conferences or meetings.</td>
<td>BP 1 – 3</td>
<td>End of Project</td>
<td>Protocols presented at AGU 2020 Fall Meeting</td>
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## Additional Success Criteria

- SOPO indicates 3 additional success criteria for the continuation application

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<tr>
<td>Field Trial Plan (Deliverable 3.4) has been received and reviewed by NETL Project Manager.</td>
<td>The field trial plan will be completed and submitted to the NETL Project Manager by the end of BP1.</td>
</tr>
<tr>
<td>Industry partners have provided letters of commitment identifying specific field sites selected for inclusion in the field trial.</td>
<td>Given the larger number of partners and regions, it has become clear that it is impractical to select sites many months in advance. Therefore, specific field sites will be selected 8-12 weeks prior to each deployment. Although specific field sites have not yet been selected as stated in the SOPO, a plan exists to select sites for each deployment period.</td>
</tr>
<tr>
<td>LDAQ solutions have been selected for inclusion in the field trial and paired with specific field test site(s).</td>
<td>The study team is engaged with over 30 LDAQ solutions in the field trial planning. While not all these solutions will meet the requirements for participation in the field trial (market-ready, and tested, or committed to testing, under controlled protocol), and not all qualified solutions will choose to participate, we expect approximately ten solutions to participate in the field trial.</td>
</tr>
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Org Chart

Department of Energy (Sponsor)

Colorado State University
Prime, Project Lead (PI: Zimmerle)

Methods Dev. Team

Methods Core Team
• Complete study team
• Statistical methods: Cooley
• Underground: Smits
• Prior testing: Ravikumar, Zimmerle, Bell
• Measurement methods: Allen

Method Review Committee (Invited Experts)

Test Team

Project Mgmt. (Bennett)

METEC Testing (Bell)

Field Measurements (CSU, UT Austin)

Equivalency Sim. (Ravikumar)

Working Committees

Field Campaign Coordination

Protocol Development

Governance

Study Team
<table>
<thead>
<tr>
<th>BP 1</th>
<th>BP 2</th>
<th>BP 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Management and Planning</strong></td>
<td><strong>Controlled Testing</strong></td>
<td><strong>Field Trial Planning</strong></td>
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<td><strong>Field Trial</strong></td>
</tr>
<tr>
<td><strong>Result Analysis and Reporting</strong></td>
<td></td>
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Task 4 – Field Trial
• Subtask 4.1 – Baselining Field Trial Site(s)
• Subtask 4.2 – Collection of Partner Data
• Subtask 4.3 – Deployment of Continuous Emissions Monitoring Systems
• Subtask 4.4 – Deployment of Survey Solutions
• Subtask 4.5 – Deployment of Ground Truth Teams

• Subtask 2.2 – Controlled Testing at METEC
  • Testing will continue including continuous monitors and survey systems
  • We expect more solutions to commit to releasing results and utilize the METEC testing budget from ADED

• Subtask 2.4 – Protocol Revision
  • Incorporating learnings from first round of testing
  • Extending protocols to support other solution types