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A Sampling of Emerging Methane Emission Quantification Technologies

Presentation to:

NGA Fall Conference

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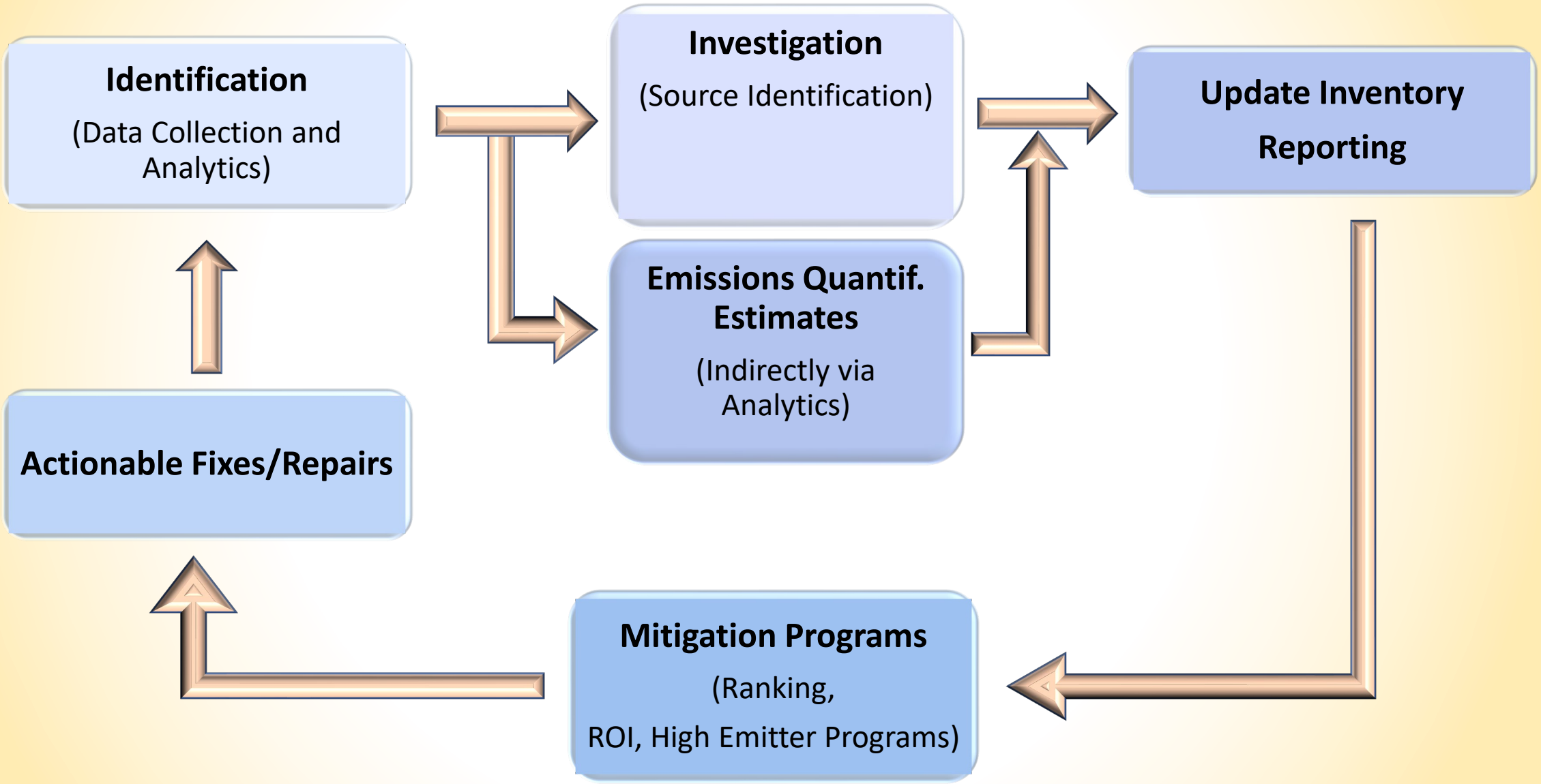
October 2022

Challenges

- **Gas utilities are being challenged to reduce methane emissions**
  - Pipes Act 2020 – explore ALD technologies
  - ESG Objectives (net-zero at some point)
- **Cost can be a major impediment.**
  - Procuring these newer technology platforms and skilled personnel can present a financial challenge – especially for smaller organizations with limited budgets.
- **Lack of standardized methodologies can be a barrier**
  - Many systems and methods.
  - No one technology for estimating methane flow rates. Sometimes a combination or suite of different technologies will be required.

Methane Reduction and EQ Framework



Technologies Today – Methane Detection and EQ

Top Down

Country-wide, Global

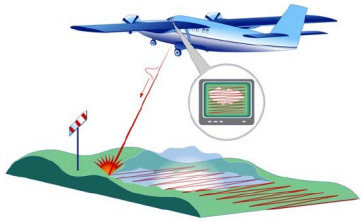
Large Areas, Regional

Large Areas, Regional

Single Source

Satellite
(High Minimum Detection Threshold)

Airplanes



Helicopter

UAV

Fixed Network

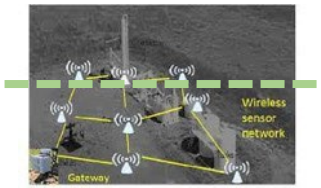


Figure 2. Wireless sensor network forming a mesh network on a well

ALD (Vehicle Based)

OGI Camera

Ultrasound

Laser

Hi-Flow Samplers

RMLDs

Satellite Based Systems

Airborne Based Systems

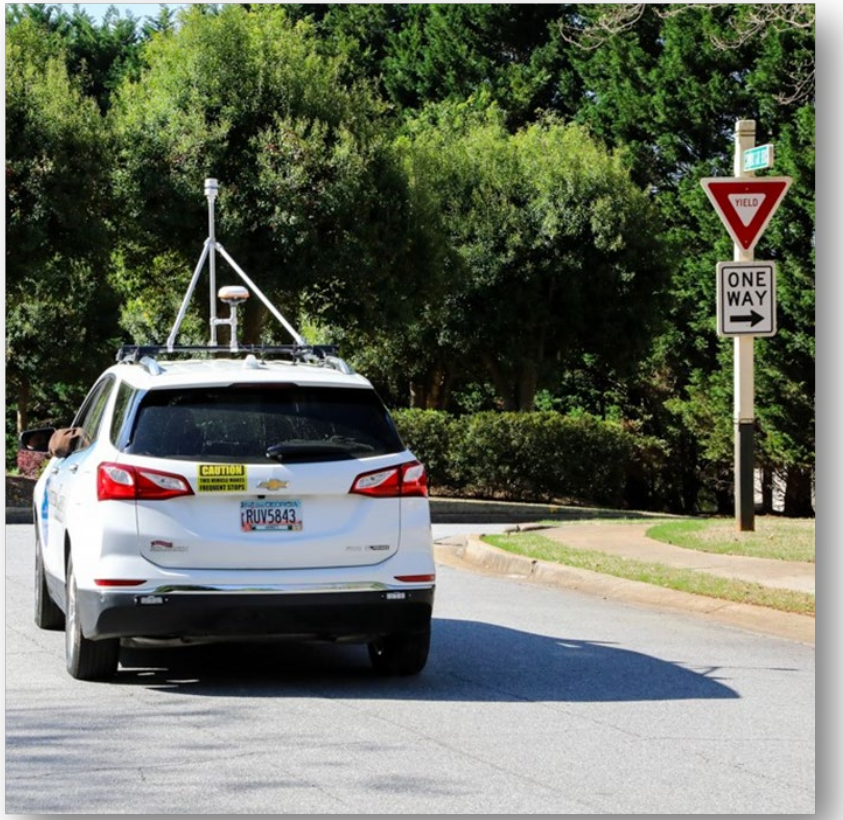
Vehicular Based Systems

Ground Based Systems

Bottom Up

One Good Choice – Vehicle Mounted Sensors + Analytics

- Fast surveys and efficient for large swaths of the LDC network
- Parts per Billion Sensors (ppb) - x 1000 more sensitive than handhelds - sense from a distance
- Much closer to the source than aircraft or satellites
- Multiple Drives give Highest Confidence in EQ
- Inclusion of Environmental Data into analytics and ML algorithms
- Small to large leaks across the network
- Ability to use survey data for
  - Leak survey and Emissions Quantification
  - Supplementary up-to-date data for pipeline replacement programs



AMLD & EQ Platform

Gas Sensor
- Ethane/Methane detection
- Parts-per-billion (ppb) sensitivity

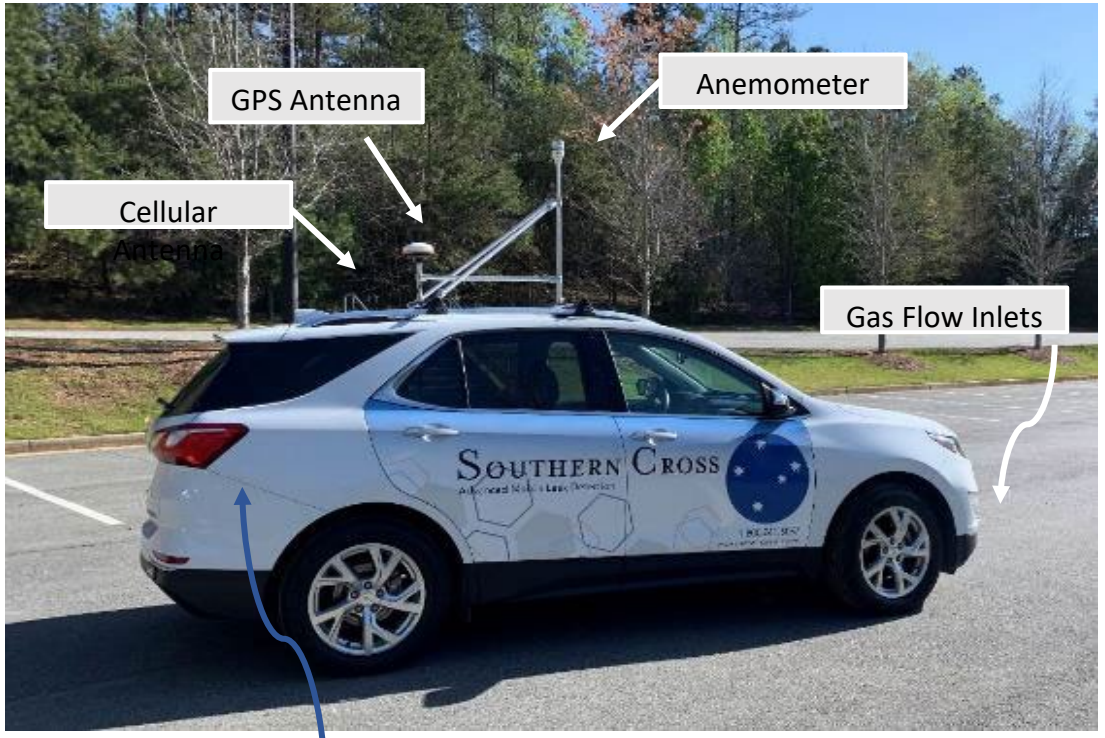
Wind Sensor
- Sonic Anemometer

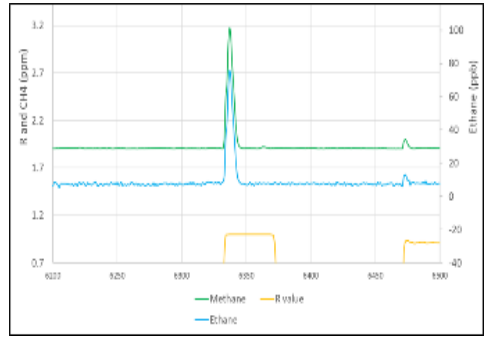
GPS Sensor
- High-precision location information embedded to all data

Auxiliary Systems
- Wireless modem for prompt data upload to the cloud
- In-car Driver tablet

Analytics
- Combine data from multiple drives
- Generate Gas Indications with GPS Coordinates
- Technician dispatching system for further investigation

Outputs can be prioritized by:
- Magnitude of gas, Frequency of detection, etc.
- Probability of Natural Gas (source discrimination)
- Confidence score
- Emissions Quantification and Ranking





SOUTHERN CROSS

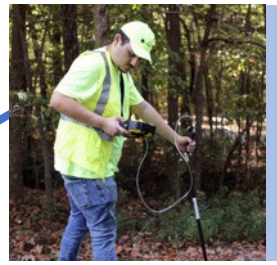
AMLD - Plays well for both EQ and Leak Survey

Data Collection

- Methane / Ethane level,
- GPS
- Wind Speed/Direction
- Atmospheric Stability

Cloud Storage And Analytics

- Raw data from multiple drives analyzed
- Source identification is derived
- Actionable Insights generated

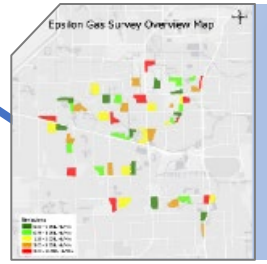


Compliance Survey (end-to-end)

- Indications (shapefiles / Tables)
- Coverage
- Gaps
- Leak grading summary
- Other Statistical Metrics

Compliance Survey (Driving Only)

- Indications (shapefiles / Tables)
- Coverage
- Gaps
- Other Statistical Metrics



Emissions Quantification

- Indications/Coverage/Gaps
- EQ Flow rates by Polygon/Grids
- Number of Sources / Polygon
- Other Statistical Metrics

"High" Emitters Program

- Indication above Threshold
- Coverage
- Gaps
- Other Statistical Metrics

Example: Leak Survey - Three Basic Outputs

1. **No Gas found** - area marked as clear

2. **Gas found**

3. **Gaps**

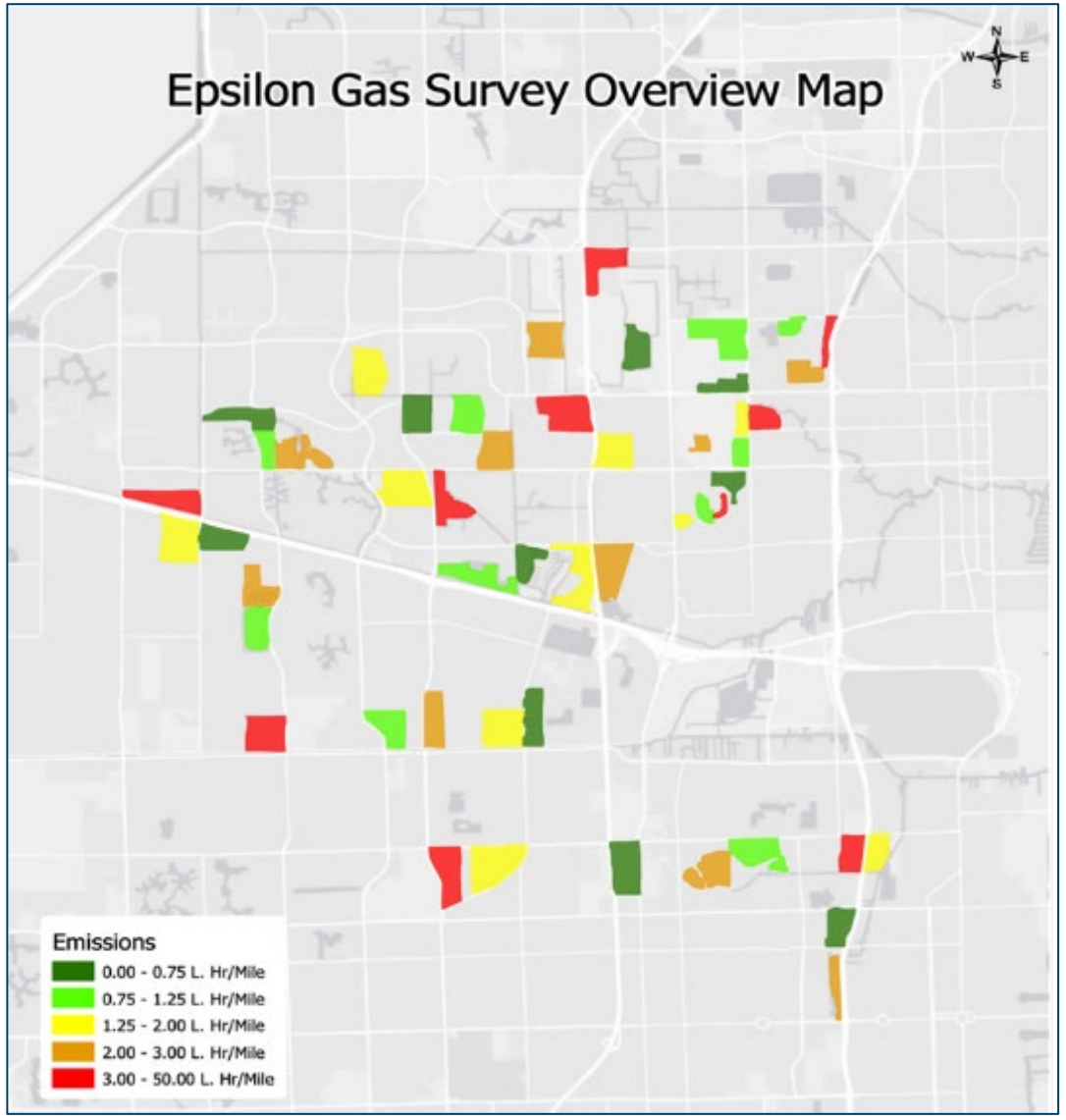
Field work consists of:

- Dispatching technician to investigating the natural gas Indications, confirming presence of leaks, grading the leaks and measuring flow rates

- Dispatch technician to surveying the Gaps for any leaks, grading the leaks and measuring flow rates

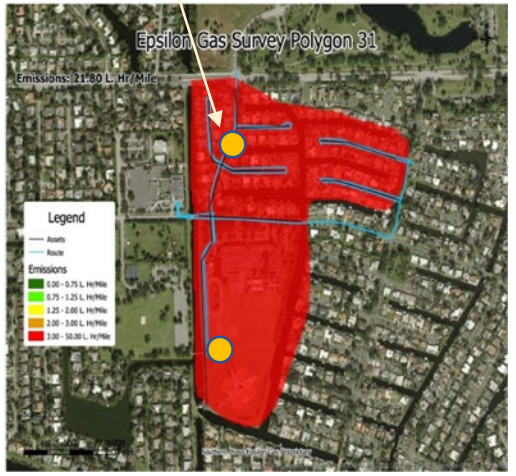
Entire area is now surveyed
(100% complete)

Example: Emissions Quantification – Heat Maps



*Verified Leak Indication

*"Super Emitter" Scenario



Thank You