Methane Emission Detection and Monitoring

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Heath History of Innovation

• 1933: first documented vegetation leak survey
• 1940: Bar hole leak survey with Combustible Gas Instruments (CGI)
• 1959: Flame Ionization methane detector
• 1988: Portable CGI with multi-gas
• 1997: Optical Methane Detector (OMD™)
• 2005: Remote Methane Leak Detector (RMLD®)
• 2007: Aerial leak survey; Fixed/Rotor: manned
• 2007: Detecto Pak-Infrared (DP-IR™)
• 2010: Optical gas cameras, Eye-C-Gas™*
• 2011: Aerial Leak Survey
• 2015: Remote Emission Monitor
• 2015: Advance Mobile
• 2016: Ultra low power NDIR*
Layers of Defense

- **Fundamental**
  - System design
  - Material properties
  - System maintenance, repair, replacement

- **Primary**
  - Periodic Leak Survey
    - Walking, mobile
  - Pipe inspection, mass flow monitoring

- **Last Resort**
  - Odorization

- **Emerging**
  - In home continuous monitoring (Utility)
  - Fast patrols
    - Faster, more frequent coverage of system
  - Continuous monitoring
    - High consequence
    - Fixed sensor networks
  - Emission estimation and leak ranking
Primary Methane Leak Detection

- Optical Infrared (DP-IR)
- Open Path Infrared (OMD, RMLD)
- Optical Gas Imaging (Eye-C-Gas)
Advanced Mobile Leak Detection

- **High sensitivity sensor**
  - Parts per billion (ppb)
  - Methane & Ethane

- **Mobile Platform**
  - Geo-located measurements
  - Survey quickly and efficiently
  - Advanced leak detection software

- **New Method**
  - Data collect
  - Analyze
  - Validate indication
  - Emission estimations

Off-Axis ICOS
Continuous Monitoring: RMLD-REM

- Fixed monitor installation
- IoT -> Cloud storage
- Data analytics
  - Leak detection
  - Emission estimations
  - Trending
- Field Pilots
  - Gas storage
  - Compressors
  - High Consequence Area
  - Oil production
UAV Leak Survey: RMLD-UAV

- Automated flight
  - Course scan to detect
  - Fine scan to localize and quantify
- Backscatter laser Spectrometer
- Proven RMLD technology
- DOE sponsored funding
- Field trials underway
- Emission estimation
Leak Survey Analytics – LSA

- Connect Leak Survey instruments to common system
- Unique features based on instrument and survey method
- Provide secure access and control for:
  - Data capture
  - Data retention and access
  - Data traceability
- Provide post analysis
  - Quality control
  - Survey management and completion
  - Area wide risk assessment; emission estimation
Leak Rate Quantification

▪ Individual Leak Quantification
  ▪ Majority of emission from minority of the leaks
  ▪ Identify and schedule repair
  ▪ Several technologies, methods and studies on going:
    ▪ Direct measurement assessment
    ▪ Theoretical algorithm calculations base on plume models
    ▪ Parametric measurements and modeling

▪ Area or pipe section quantification
  ▪ Identify pipe sections of higher risk or emissions in total
  ▪ Schedule replacement based on risk and emissions
    ▪ Leaks per mile or area
    ▪ Emission estimates base on models