GTI Overview

80 Year History of Turning Raw Technology into Practical Energy Solutions

World-class piloting facilities headquartered in Chicago area

400+ EMPLOYEES

TOP WORK PLACES 2020
Chicago Tribune

Collaborative Organizations and Programs

Working with utilities to address critical challenges

OTD Operations Technology Development

UTD Utilization Technology Development

LCRI LOW-CARBON RESOURCES INITIATIVE

HYDROGEN TECHNOLOGY CENTER

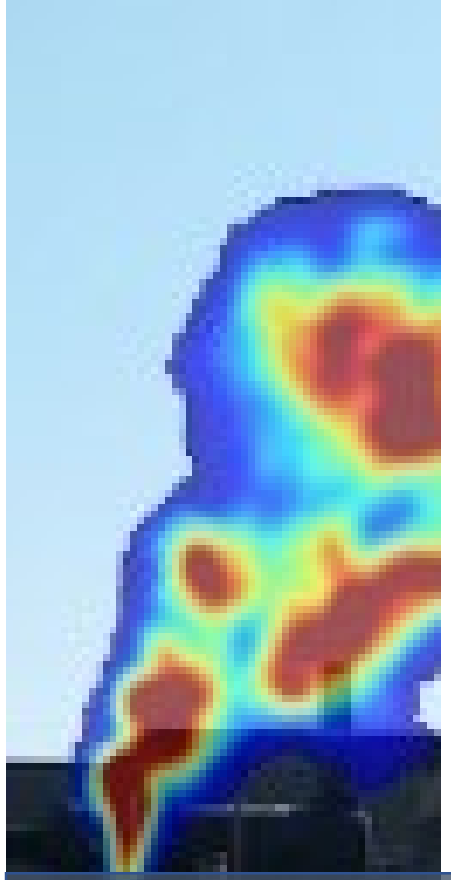
QH_4 COLLABORATORY TO ADVANCE METHANE SCIENCE

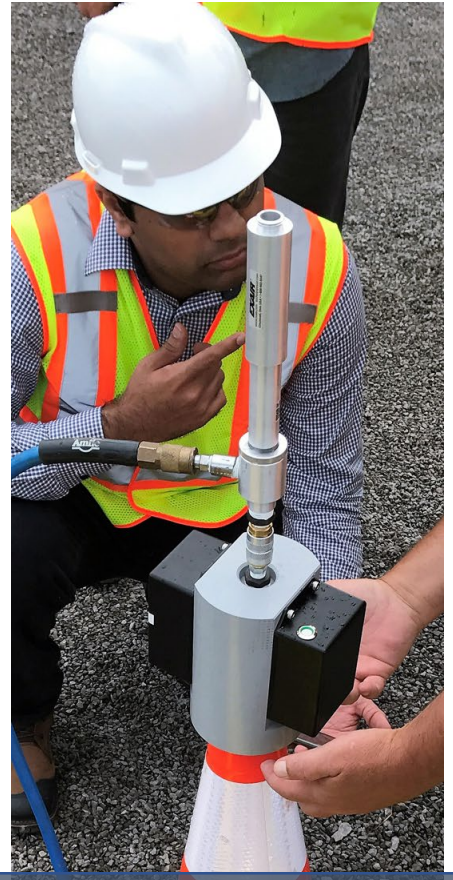
CMR CENTER FOR METHANE RESEARCH

Methane Detection and Remote Sensing

Flexibility to deploy multiple technology SOLUTIONS

- Technology Development
- Technology Evaluation
- Modeling
- Methodologies
- Measurement Studies





Technology
- Sensor Type
- Detection
- Quantification
- Measurement

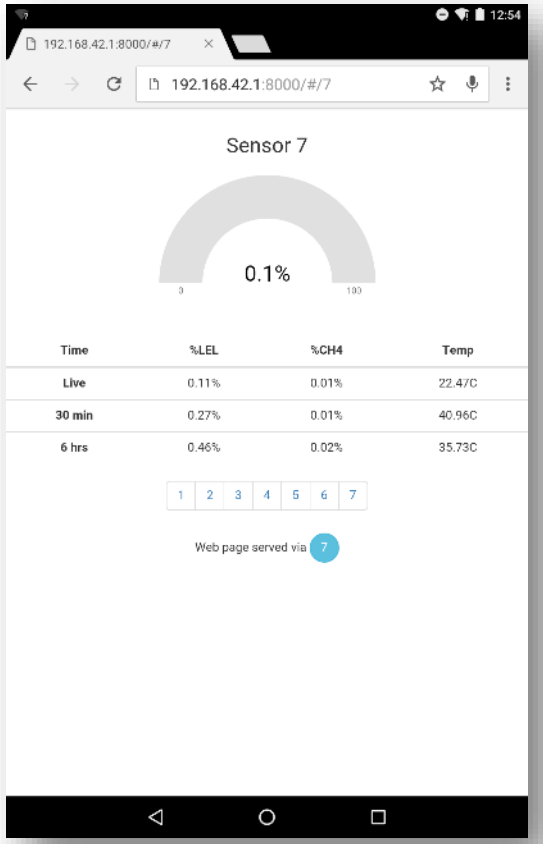
Platform
- Hand-held
- Vehicle
- UAVs
- Drones
- Aircraft

Asset
- Pipelines
- M&R Stations
- Compressor Stations
- Meters

Use Case
- Leak survey
- Leak Investigation
- Stationary Monitoring
- First Responder

First Responder Methane Detectors

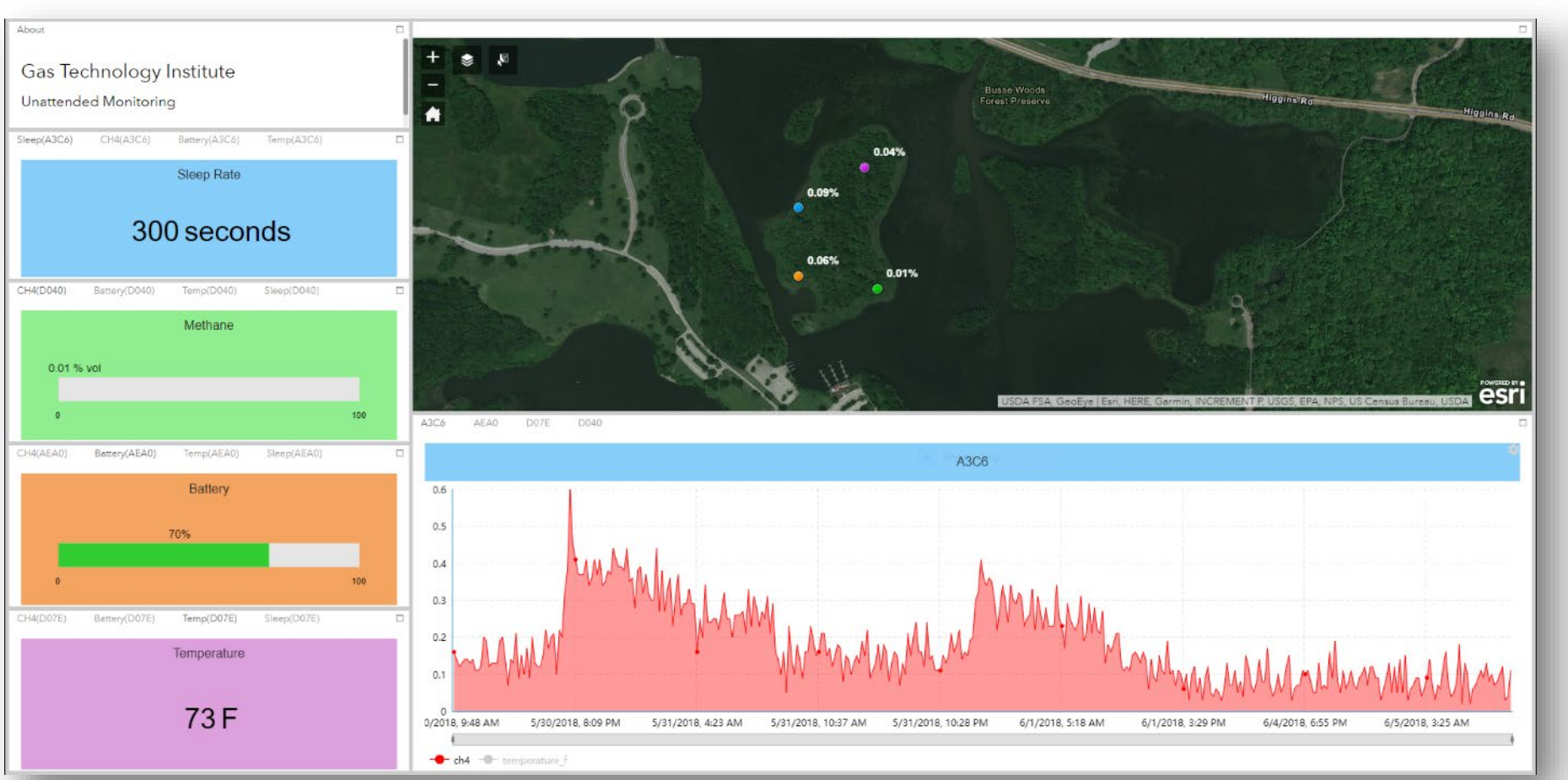
- Multi-point methane concentration reporting
  - Mesh network topology (100m distance)
  - Use your smartphone to access readings when nearby
  - 2 second update interval
  - Inlet fan to gather samples
  - Indoors / outdoors / mix

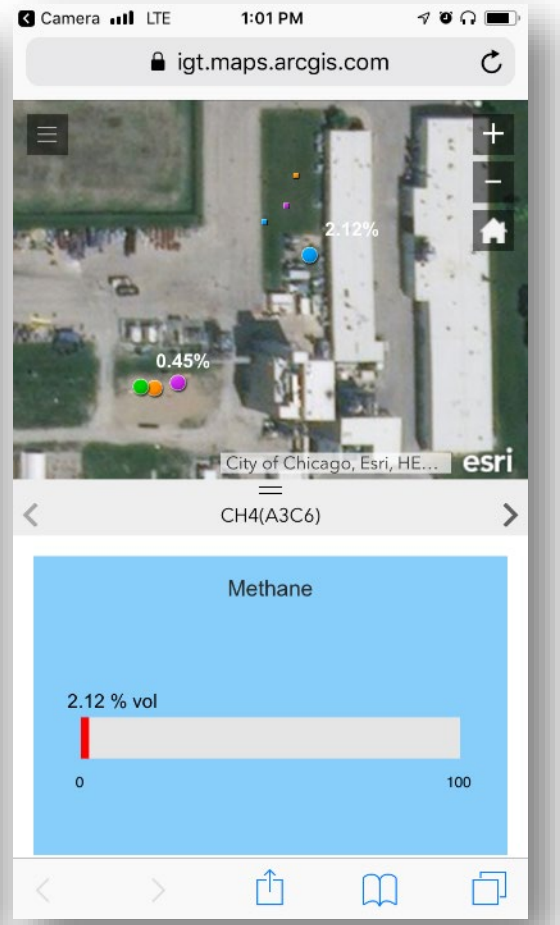


Unattended Methane Monitors

- Remote multi-point methane concentration reporting
  - Star network topology
  - Deploy with survey123 to add GPS point
  - Use ArcGIS dashboard to access readings from anywhere
  - Concealed within ground
  - Long battery life (2wk-3month)

Unattended Methane Monitor ArcGIS Dashboard



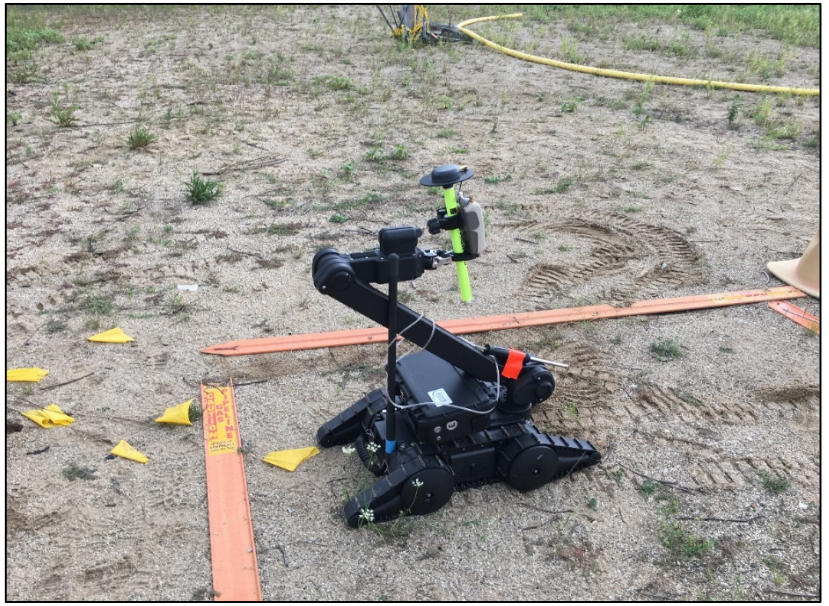


Handheld Laser Methane Sensors

- Several new handheld laser methane (or RMLD-type) sensors have been introduced to the market in the last few years
- Potential time savings and increased safety if new sensors perform as well or better than the existing RMLD technology
- Evaluated sensors under a range of lab and field test protocols
  - Distance
  - Obstructions
  - Backgrounds

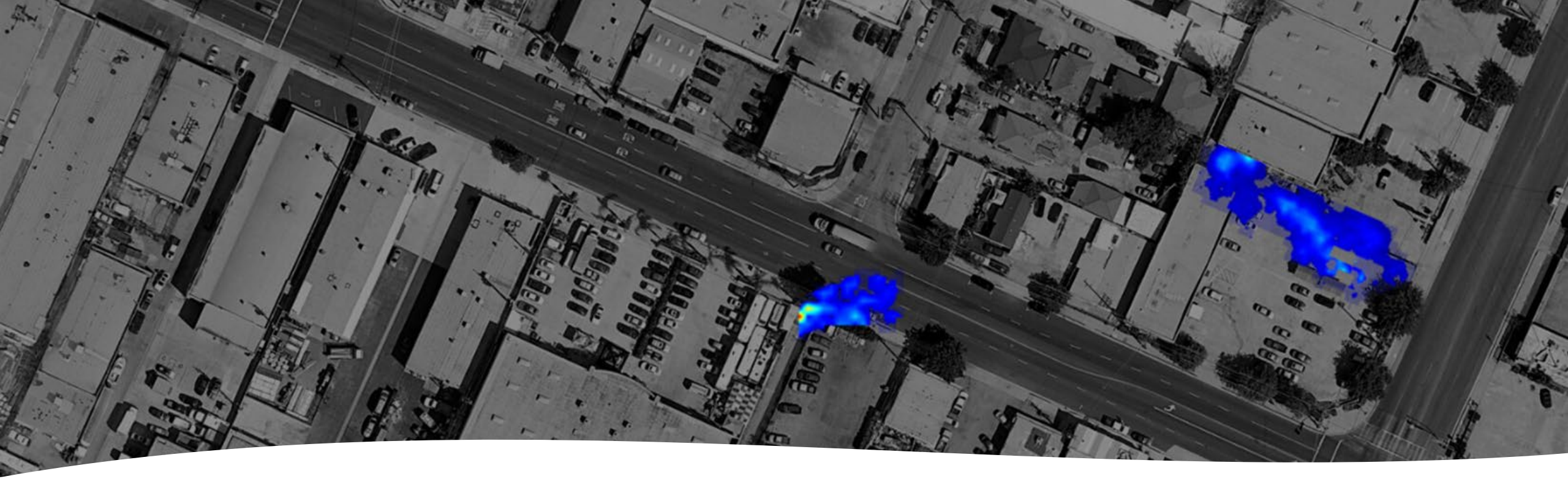
Robot for Methane Detection

- Focused on first responder use case of evaluating a gas filled structure
- Selected and tested a tactical deployment robot
  - Maneuverability
  - Climbing Stairs
  - Opening Doors
  - Distance/Signal Tests
  - Methane detection



OTD/DOT PHMSA – Evaluation of Remote Sensing Leak Detection PHMSA # 693JK31910006

- Work with drone developer Seekops, Inc to produce a drone platform tuned to transmission pipeline leak detection and integrity threat monitoring
- Focus on hard to access areas
- Establish a full system testing framework
- Conduct testing at
  - Large scale field laboratory
  - Real world sites
- Collaborating with University of Dayton on integrity threat identification



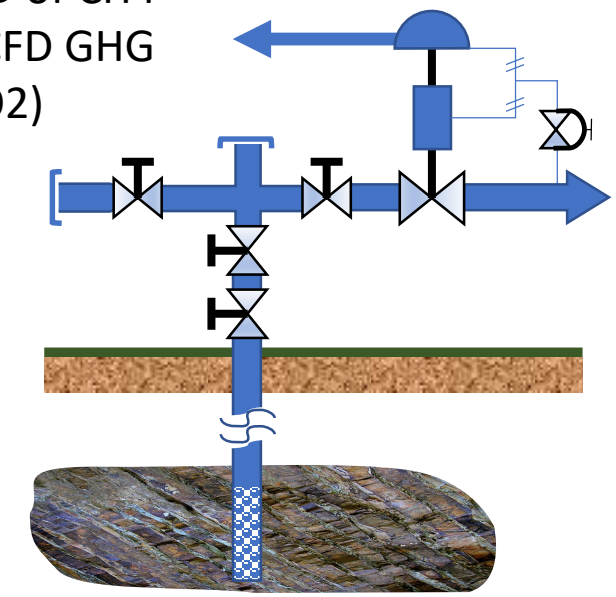
Air Based Sensor Research Gaps for Distribution

- Development of air-based platforms focused to up-stream use cases (e.g., production and processing)
- Need to develop and evaluate technologies for use in distribution
- Distribution assets have different sets of challenges than distribution:
- Crowded source space – localization difficult
  - Leaks are typically small – detection without a bunch of FPs a challenge
- False positive minimization is critical to maintaining cost benefits of air-based leak detection, since each leak detected must be verified by ground crews.

Methane Mitigation Thermo-Electric Generator (MMTEG) Reducing Emissions at the Wellhead

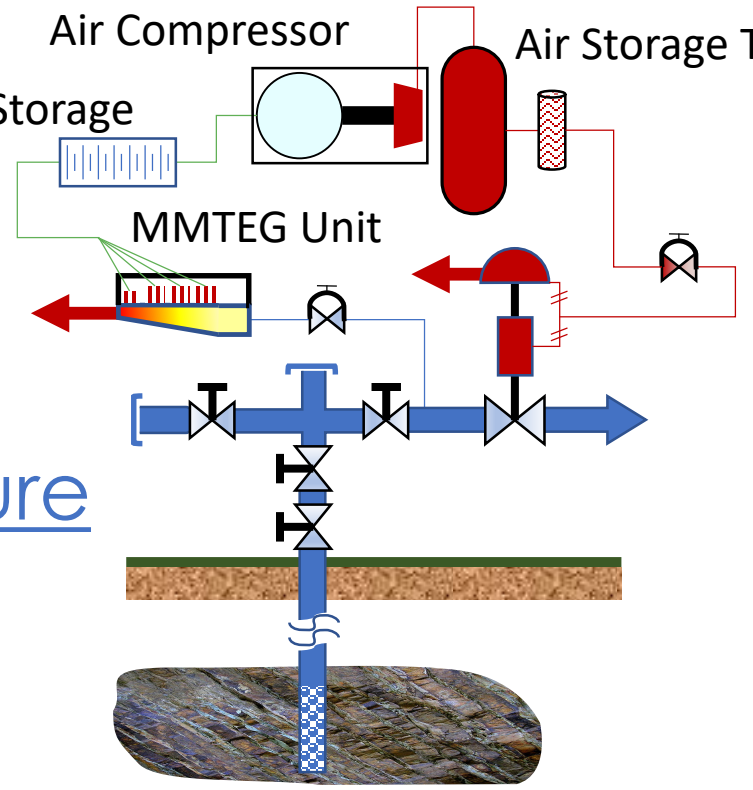
Current

Actuator Vent
252 SCFD of CH4
(7056 SCFD GHG
Equiv CO2)



Future

Air Compressor
Air Storage Tank
Battery Storage
MMTEG Unit
Burner Vent
1.59 SCFD CO2
Emitted



Reduces emissions by 1000X & Increases Revenue

Methane Mitigation and Leak Recovery at Compressor Stations – Linear Compressor Technology

- Method for capture & recovery of natural gas compressor leaks
  - ~50 Bcf per year of methane slip from compressor sections in 10,000 natural gas compressors in U.S. ~$1 Billion per year lost across value chain