

Advancing an Opportunity:

Methane Imaging, Quantification and Management

A CH₄IQ/SRRR/LMI/ACRE Collaboration with a National Lab team led by

Lawrence Berkeley National Lab

Addressing the methane emissions challenges of

- Above & Below Ground Natural Gas Pipe Leaks*
- Orphaned/Abandoned & Under-Producing Well Emissions*
- Integrated Methane Monitoring Management System*

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Natural Gas Supply Chain:

Sector Methane Emissions & Mobile Monitoring

SRRR

CH₄IQ

The Project applies mainly to distribution lines & orphaned wells

Fed Focus

Production & Processing

1. Drilling and Well Completion
2. Producing Wells
3. Gathering Lines
4. Gathering and Boosting Stations
5. Gas Processing Plant

40 – 60% of emissions

Orphaned wells & lines

PHMSA Focus

Natural Gas Transmission & Storage

6. Transmission Compressor Stations
7. Transmission Pipeline
8. Underground Storage

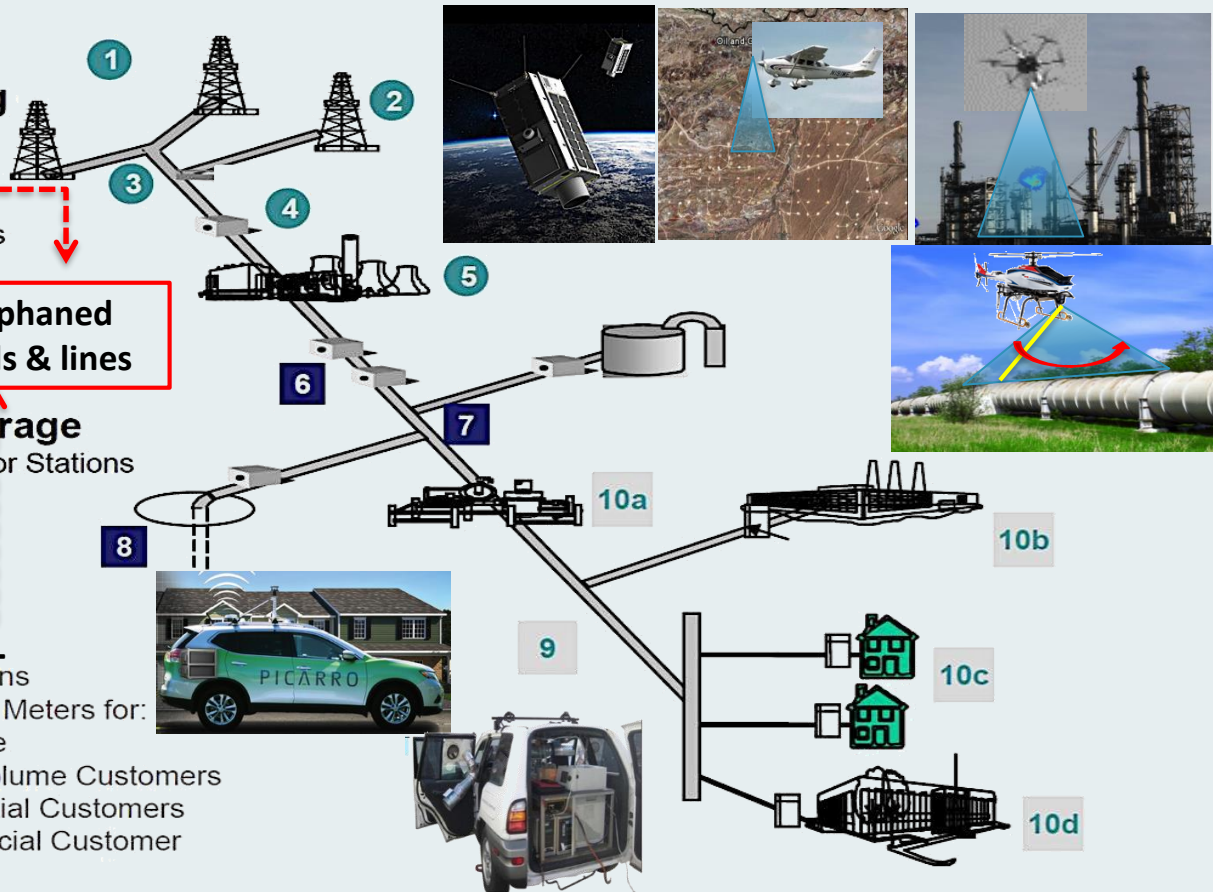
~ 25% of emissions

Opportunities

16 – 32% of emissions

Distribution

9. Distribution Mains
10. Regulators and Meters for:
 - a. City Gate
 - b. Large Volume Customers
 - c. Residential Customers
 - d. Commercial Customer

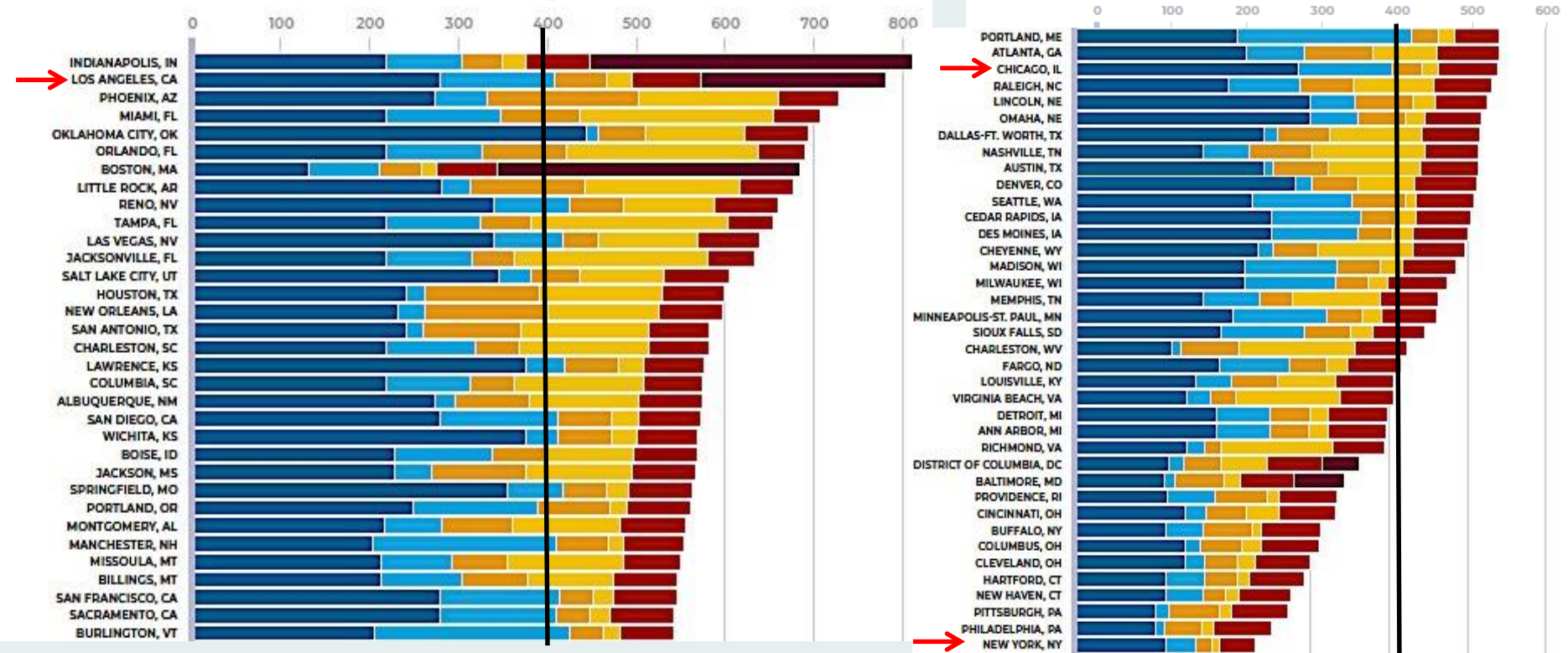


Cities w/emissions to the right of the black line = heavy emitters

LEAKAGE RATE FOR RESIDENTIAL/COMMERCIAL USE (GRAMS METHANE PER MCF GAS)

■ Production Areas ■ Transmission ■ Distribution ■ Gas Meters ■ Buildings ■ Additional

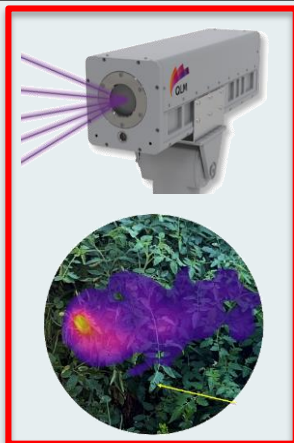
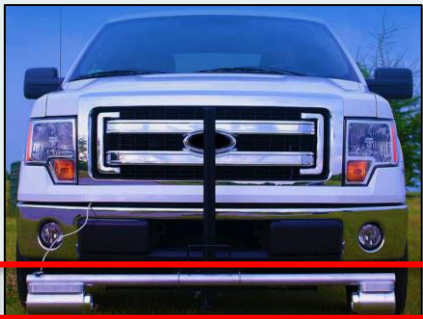
Each 100 grams methane per MCF gas = 0.5% leakage



Mobile High-Sensitivity Air Samplers "Sniffers" (No localization, Poor quant)

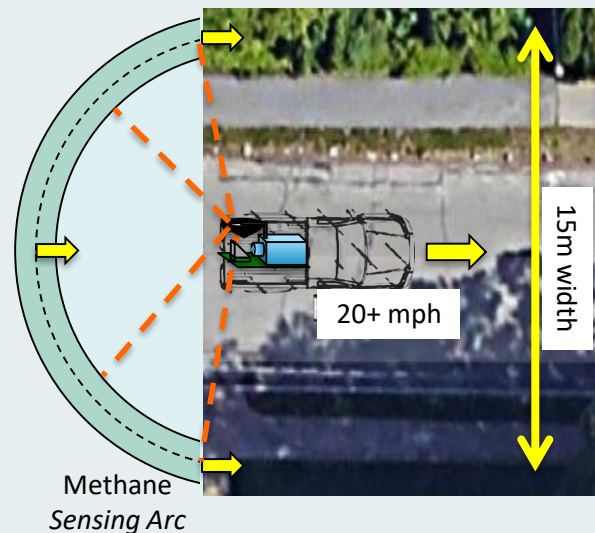
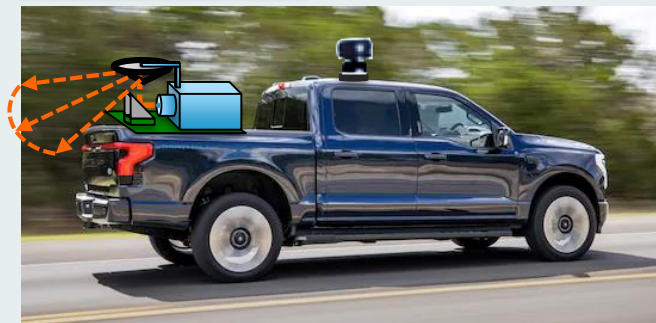


Mobile Front-Mount Lasers (Misses roadside emissions, No quant)

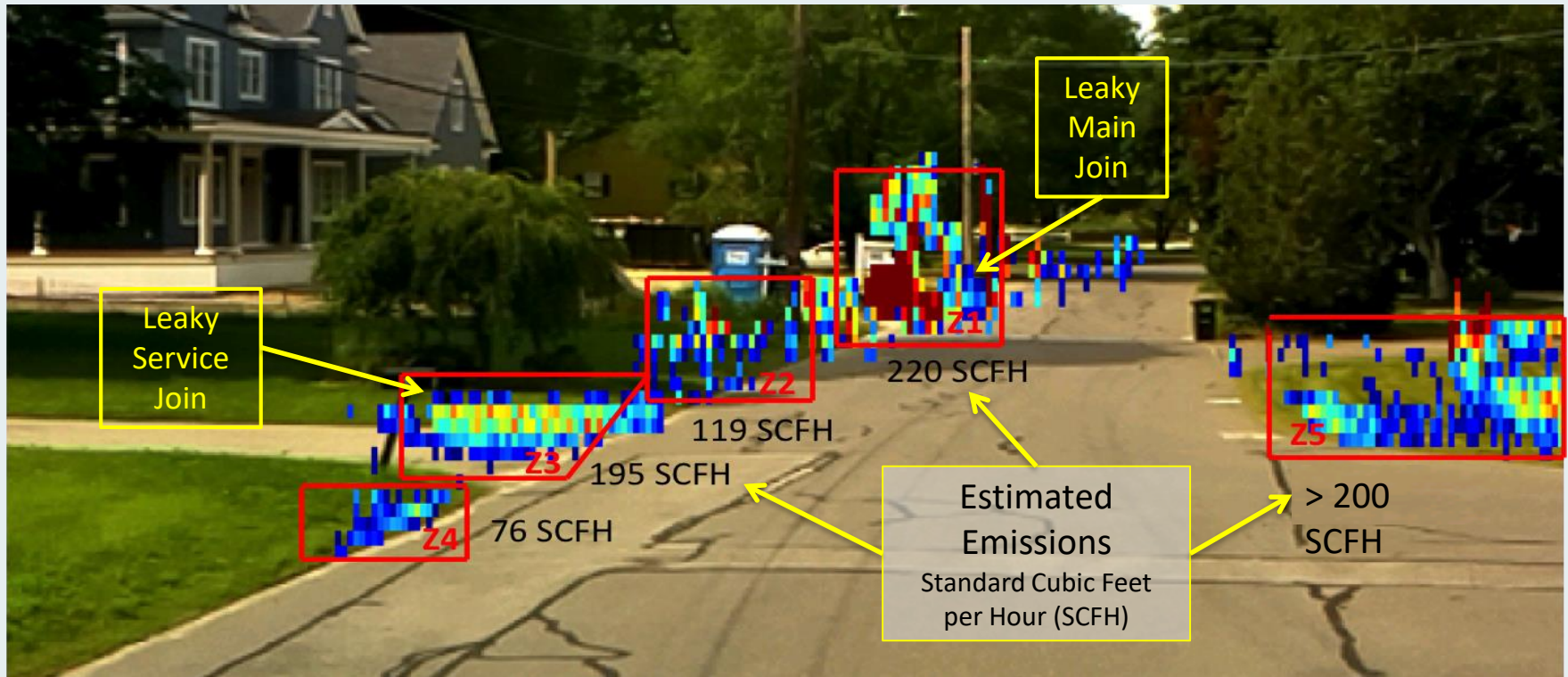


Our Mobile Methane IQ Mapper
Imaging, Quantification & Mapping
(Rapid Development using Existing Tech)

- QLM Tech. LiDAR
- Wide-field optics
- Wind sensor + GPS
- Real-time Processor
- LLcloud post-processor
- Electric F-150 truck



Example Image of Methane Surface Emissions Failed Replacement of an Underground Natural Gas Main



- Super-Emitters along roadsides due to **poor replacement of a gas main**
- Imaging & quantification using a prototype SWIR spectral video camera (2017)

In forest, fields, desert, water

- Open Pipes
- Holes in the Ground
- Leaky Wellheads & Casings
- Pumpjacks & Leaky Wellheads

Possibly millions of OWs in US

- 90% emissions from unplugged wells emitting > 10 g/hr
- *Need method for rapid triage of emissions from OWs*



Flux Chambers & High-Flow Samplers Sensitive but Slow

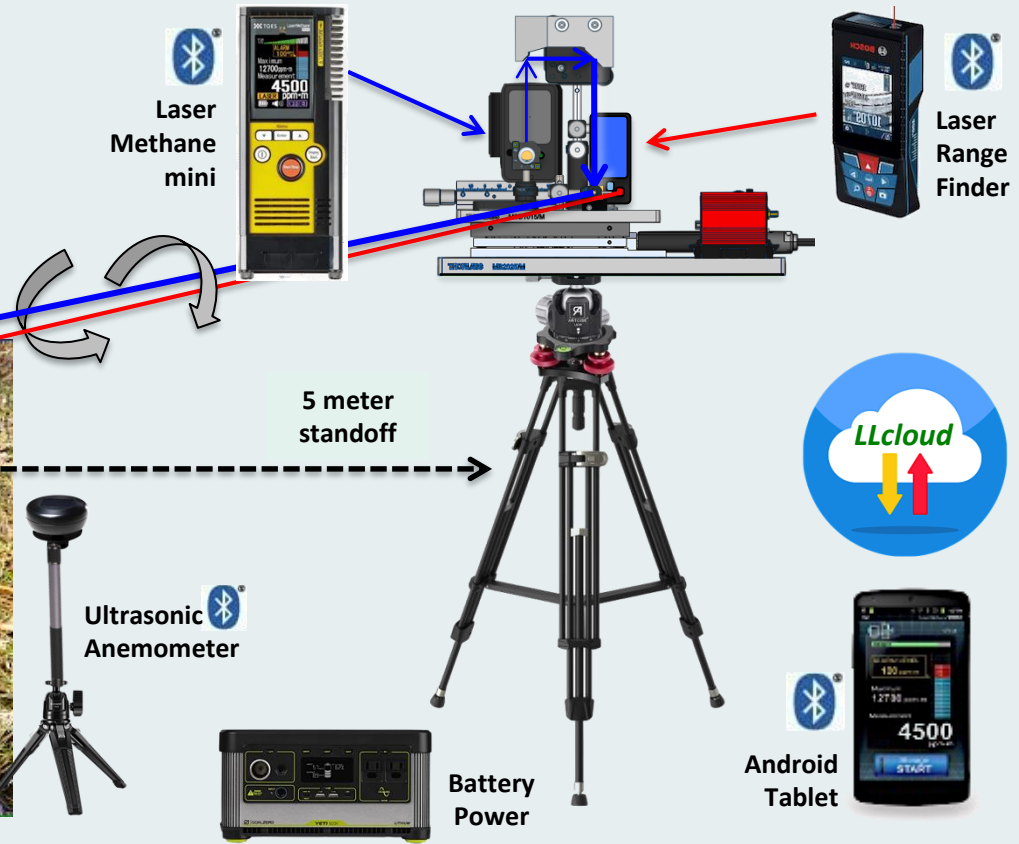


Source: EDF

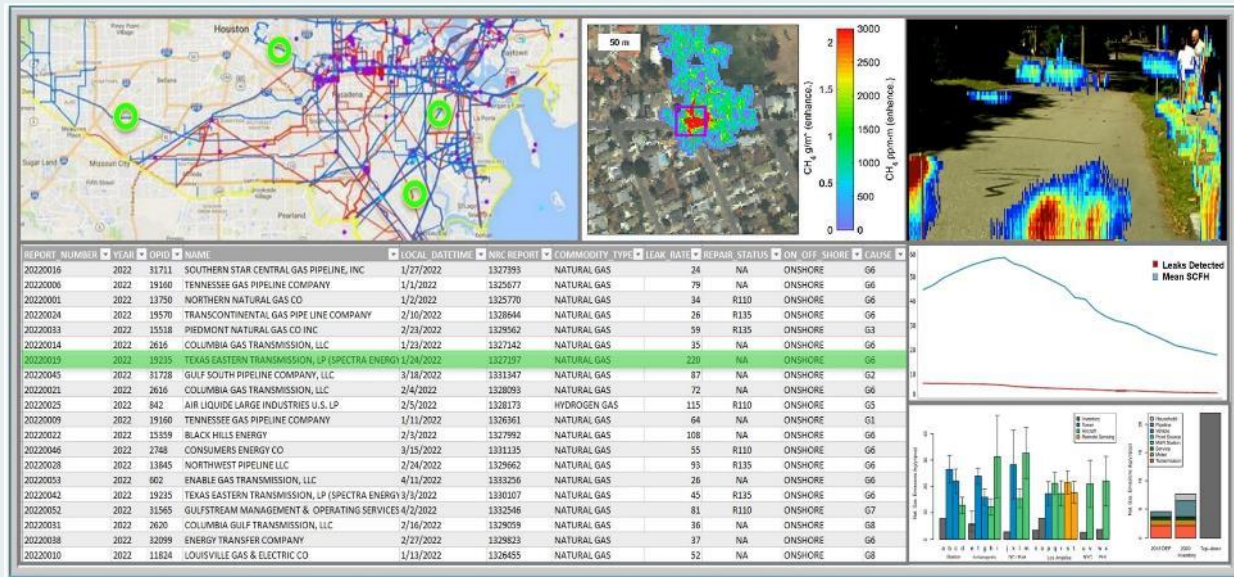


Low-Cost Methane Scanner Concept of Operation Emissions Imagery & Flux Estimate Transmit to the Cloud

Scanned Image Resolution: 1.5cm (horizontal) 2.0cm (vertical) at 5 meters standoff	2 Samples per second: 5 minute scan → 30 x 20 pixel image 45cm x 40cm (18" x 16")
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- System-wide view
 - Leverage what exists where possible
 - Drill down to specifics
- Breakout data
 - Geographic region
 - Sector of supply chain
 - Administrative responsibility
- Tailored stakeholder dashboards
- Alerts on detected emission events, leaks and repairs
 - Mobilize response
- Quantify GHG reductions
- Visualize improvement over time!
- Potential for Machine Learning and Artificial Intelligence
 - Predictive maintenance
 - Proactive repair



- **No one knows the magnitude of the problem.** Many studies expose this uncertainty
 - **Locating & Quantifying leaks is essential** to achieve GHG reduction goals
 - **Our demonstration at PG&E test site July 2023.** Gas companies, National labs & California regulators present said “Good technology, definitely a breakthrough”
- Next Steps
 - **White House/NASA** National methane monitoring system helps meet goals on infrastructure & climate. Investing less than 1% of the budget for emissions into measurement will make the other 99 % of the budget much more effective
 - **Collaborative agreements among SRRR/CH₄IQ/LMI/ACRE team, National Labs and gas utilities.** Build the technology team to develop & implement proposed systems, CA as a testbed on distribution lines, PA as testbed on orphan wells.
 - **Start up private funding to accelerate the launch at Berkeley prior to government funding**
 - **Secure Federal & State funding to work on** orphan wells, distribution & gathering lines at state wide and national scales.



Support from Federal & State Agencies

www.lbl.gov

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Budget allocations from existing or new methane abatement programs - to the Methane, Imaging, Quantification & Management Project.



Support from Individuals and Foundations

<https://www.berkeleylabfoundation.org/support>

Berkeley Lab Foundation

By check, transfer or credit card: unrestricted funds to the Methane Imaging, Quantification & Management Project.