New Technologies and R&D Efforts on Leak Detection and Methane Emissions

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CPUC Workshop on Methane Emissions
**April 6th, 2015**

PG&E®

Company Profile

- **Pacific Gas and Electric Company, incorporated in California in 1905, is one of the largest combination natural gas and electric utilities in the United States.**

- The company provides natural gas and electric to approximately 15 million people throughout a 70,000-square-mile service area in northern and central California.

- Service area stretches from Eureka in the north to Bakersfield in the south, and from the Pacific Ocean in the west to the Sierra Nevada in the east.

Gas Operation Key Statistics

- 5,800 miles of gas transmission pipeline

- Approx. 42,000 miles of gas distribution pipe

- 4.3 million natural gas customer accounts.

- Deliver 970 BCF/year (2.6 BCF/daily average)

PG&E GAS TRANSMISSION PIPES

— GAS TRANSMISSION PIPES
☐ GAS SERVICE TERRITORY

scale 1:5,000,000
one inch represents approx 80 miles
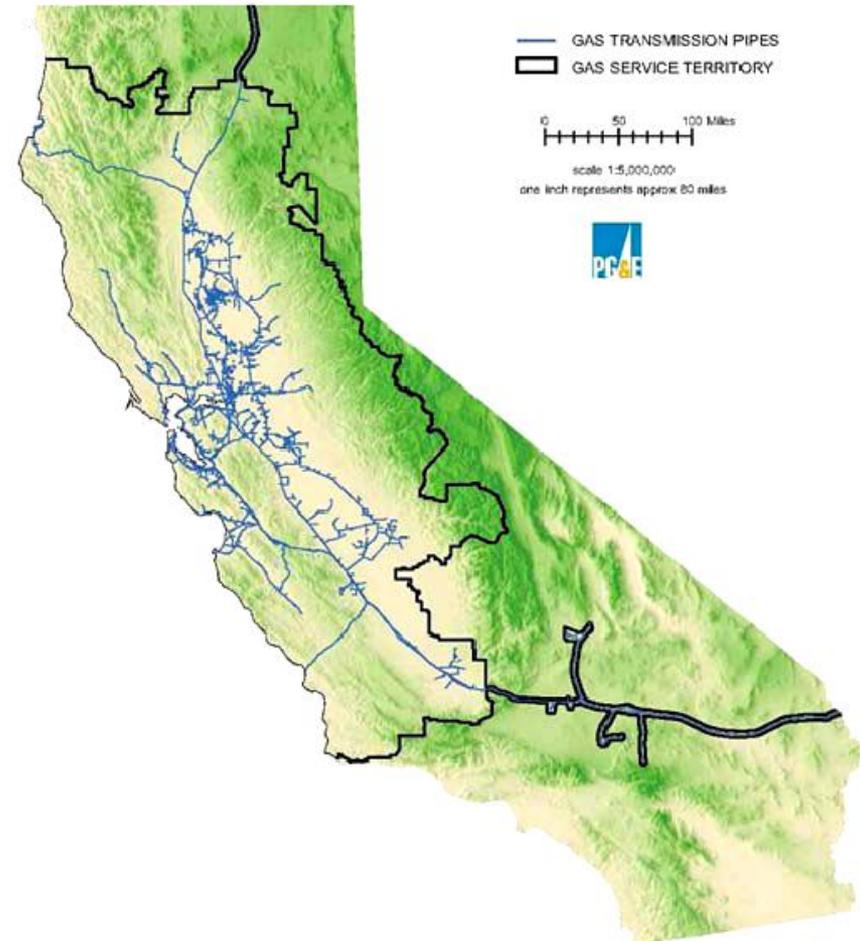
Leak Detection

High Sensitivity Methane Detector

- Cavity Ring Down Spectroscopy (CRDS) detects methane concentrations as low as 1ppb.

- Allows a more effective sweep of an area with a vehicle to identify possible leaks.

- Data are transmitted immediately and can be viewed remotely in real time.

- PG&E reinvented its leak detection and repair process to capture economies of scale provided by the technology: Super Crew concept.

Ref: Steve Redding, Glenda Blaze. "Revolutionizing Leak Management" , 26th World Gas Conference, Paris June 1-5, 2015

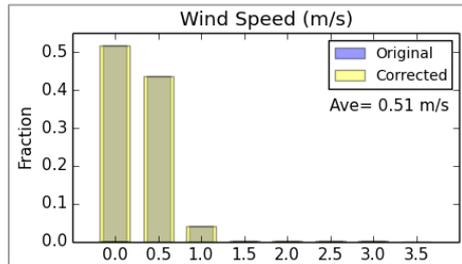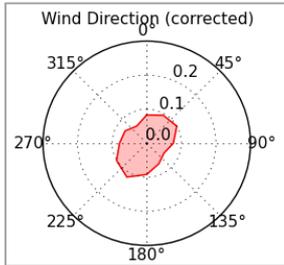Steve Redding "Introduction of Picarro Surveyor Technology at PG&E" 2013 AGA Operations Conference Orlando, FL May 23rd, 2013
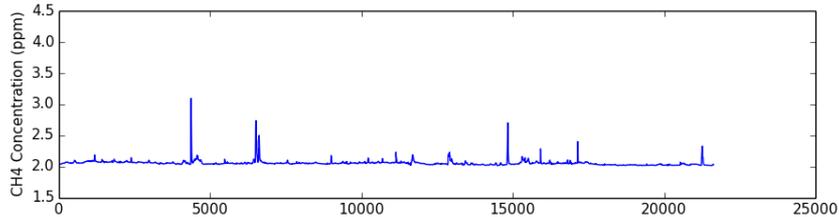
2014 North Bay leak survey on June 25th

Morning (1 AM)

Concentration	(ppm)	Intensity	(ppm)
Max	3.094	Min Peak	0.0
Ave	2.053	Max Peak	0.919
Median	2.048	Above threshold	244 counts
Ave-Min	0.039	Ratio	5.93 %
Missing data	9 rows	% missing data	0.22 %

Evening (8 PM)

Concentration	(ppm)	Intensity	(ppm)
Max	1.888	Min Peak	0.0
Ave	1.808	Max Peak	0.051
Median	1.807	Above threshold	91 counts
Ave-Min	0.008	Ratio	0.95 %
Missing data	0 rows	% missing data	0.00 %
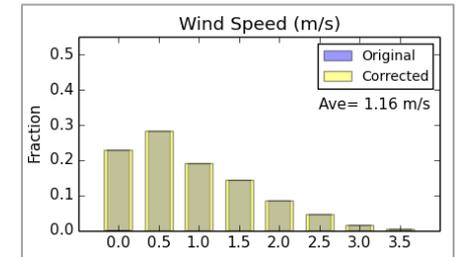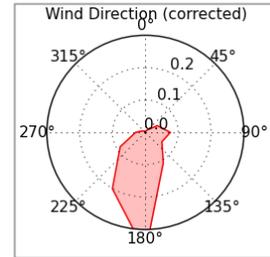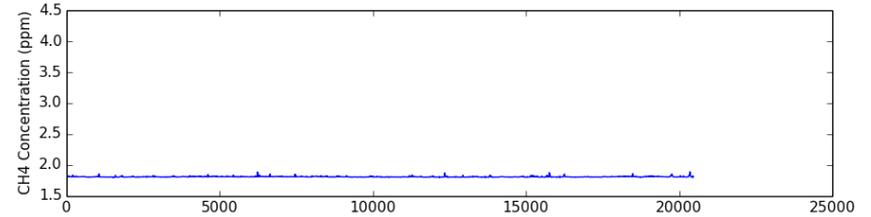
Stationary Methane Laser Sensor

Installed Remote Methane Leak Detector at PG&E Livermore Training Center (February 2013)

- Continuously monitors pipelines and provides rapid warning for leaks.

- System consists of sensor, weather station, camera and computer station.

- Testing of the system co-funded with the California Energy Commission:

  - Demonstration of sensor efficacy

  - Evaluation of sensor response to leaks in typical operating scenarios and weather conditions

  - Elimination of false alarms

- Project is completed. Results were presented at the 2014 AGA Spring Conference.

  Ref: Paul Wehnert et al. "Continual 24/7 Pipeline Monitoring System for Leakage" , 2014 AGA Operations Conference Pittsburgh, PA May 21st, 2014
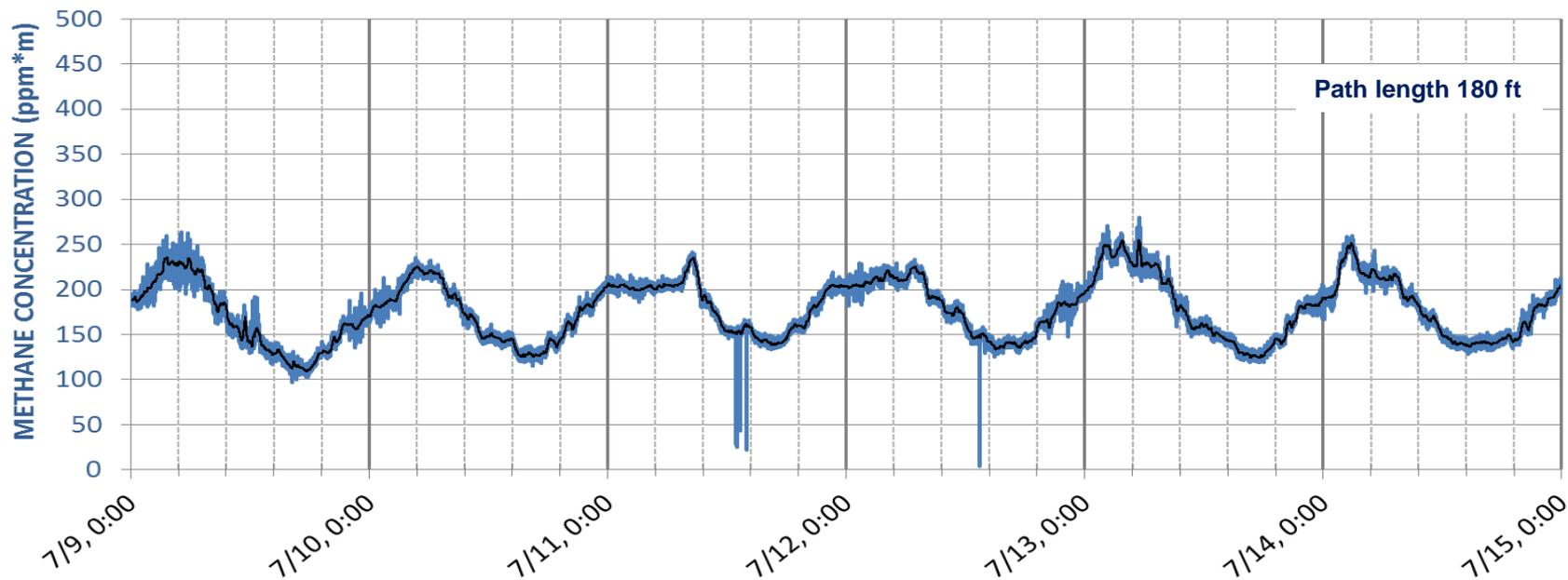
2013

Design › Develop › Test › Deploy

Daily Fluctuations of Methane Concentrations

- Variations in methane concentration were observed during the Stationary Methane Laser Sensor test in Livermore in Summer 2013.

Handheld Methane Detector

Using the handheld methane detector to pinpoint simulated leaks at Livermore training center (December 2014)

- The handheld methane detector utilizes the same laser based technology that NASA has installed on its planetary rovers to detect methane on Mars.

- The tool has superior sensitivity (parts per billion) compared to other commercial handheld detectors. It is also lightweight (150g).

- When completed, the tool is expected to reduce time taken to locate leak in association with vehicle based survey.
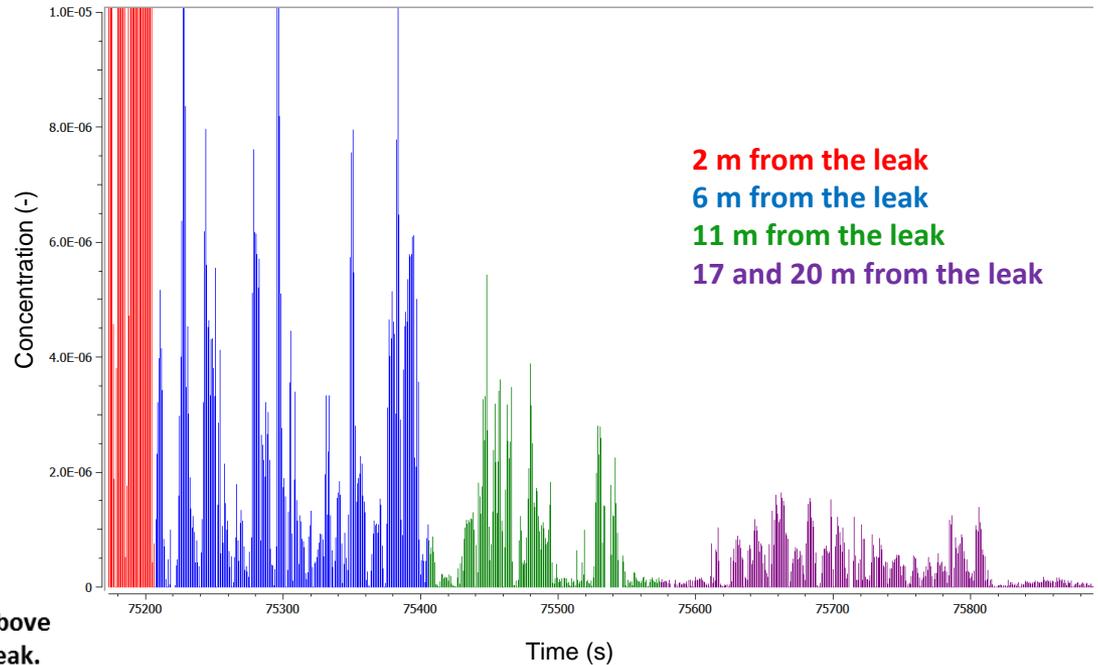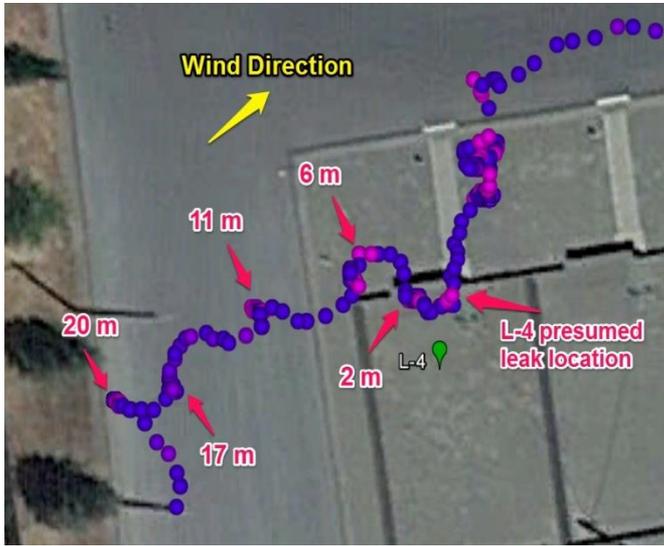

Prototype of handheld methane detector (December 2014)

http://www.pgecurrents.com/2014/11/04/video-pge-adapts-mars-rover-technology-for-gas-leak-detection-tool/

| 2013 | | | 2015 |
| Design | Develop | Test | Deploy |

Wind Direction
6 m
11 m
20 m
L-4 presumed leak location
2 m
L-4
17 m

Concentration (-)
Time (s)

2 m from the leak
6 m from the leak
11 m from the leak
17 and 20 m from the leak

Evolution of the average methane concentration above background in function of the distance from the leak.

$y = 21476x^{-1.926}$
$R^2 = 0.9935$

Intensity (ppb)
Distance (m)
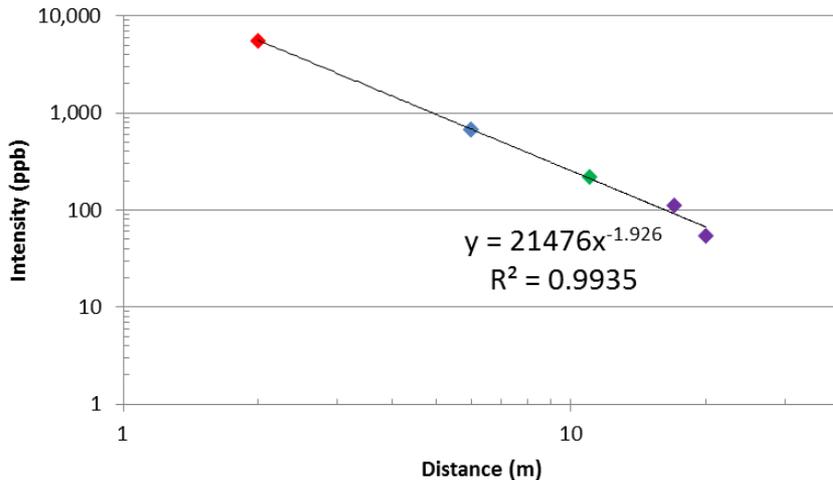
■ First observations:

– Concentration decreases with distance

– Wide fluctuations at all distances

– Average concentration seems to show a horizontal and vertical diffusion

– Diffusion is much faster than predicted by traditional plume models.

$$C(x) = \frac{Q}{U \cdot 2 \cdot \pi \cdot I_y \cdot I_z} \cdot x^{-2}$$

sUAS Methane Detector

JPL methane detector mounted on a small quadrotor

- JPL lightweight methane detector mounted on a small drone to detect methane and locate leak.

- In preparation of FAA's regulation of commercial applications of drones in September 2015.

- Totally automated drone that can be launched by utility crew in the field to survey portions of pipeline or facilities and locate leaks.
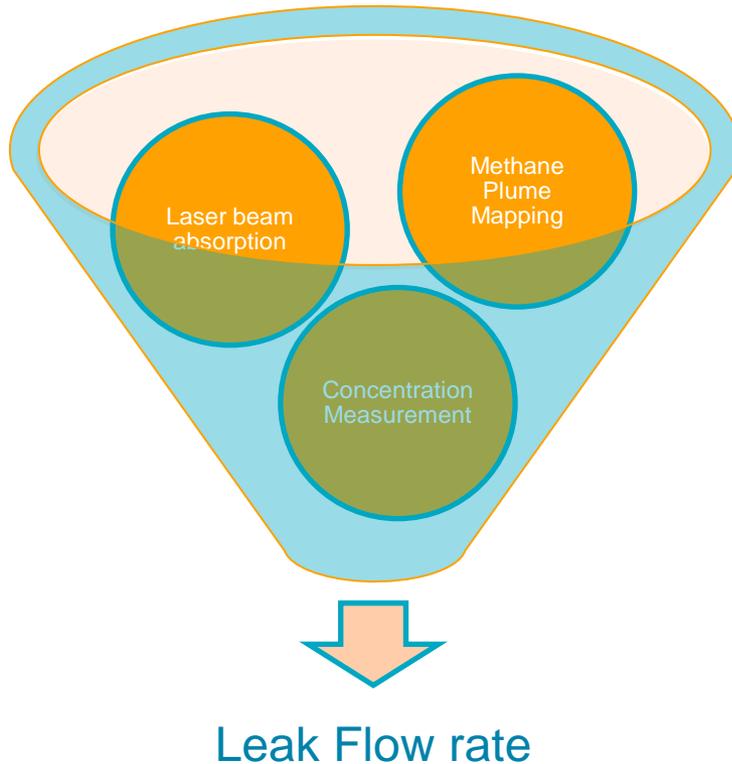
2015

2016

Design > Develop > Test > Deploy

Methane Emission Quantification

New Techniques to quickly estimate leak flow rates in urban environment

Laser beam absorption

Methane Plume Mapping

Concentration Measurement

Leak Flow rate

- Broad call for ideas through an RFP.

- Selection of most promising existing technologies and testing them in controlled environment and in the field.

- Propose validated methods that may be deployed to assess methane emissions of non-hazardous leaks.

- Expand repair programs to include non-hazardous leaks based on methane emissions.

Design | Develop | 2015 | Test | 2016 | Deploy

Schlieren Gas Imaging
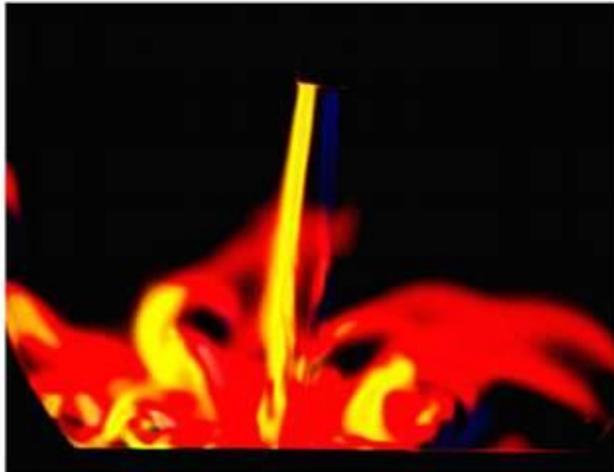
Using Schlieren optical imaging to visualize propane gas flow

- Schlieren technique offers a visual method to observe leak flow remotely.

- Contrast is achieved based on differences in refractive indexes of gases.

- This NYSEARCH project explores the potential that Schlieren imaging holds for leak *quantification* by measuring fluid flow properties of gas plumes.
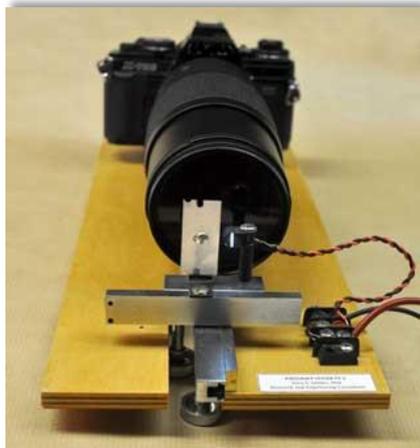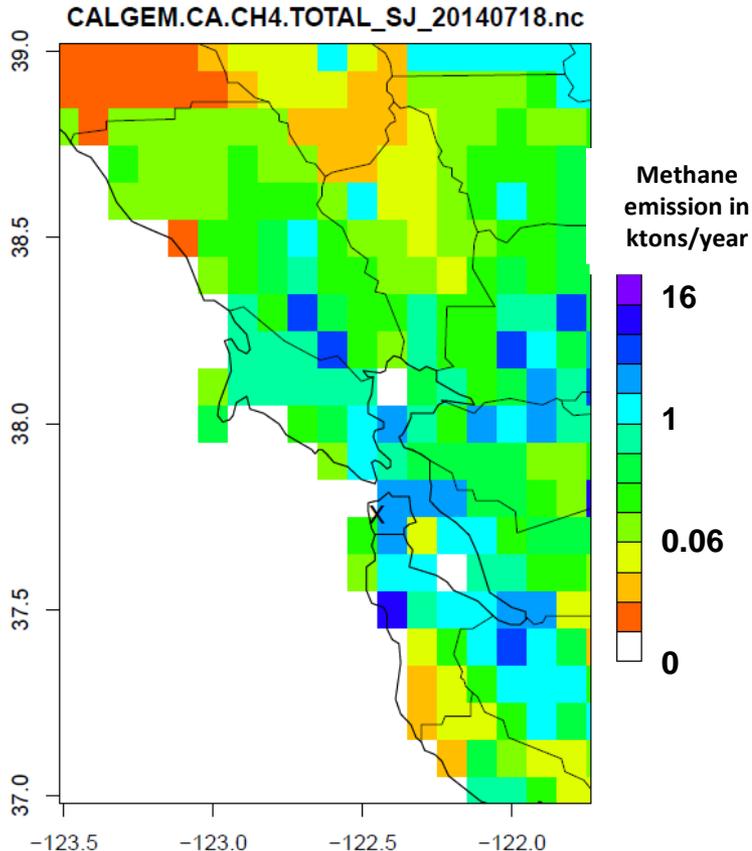

A simple Schlieren system set-up

Lab Schlieren image of helium flow

2015

Design Develop Test Deploy

Support (No funding by PG&E) to: BAAQMD's methane emissions inventory

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

CALGEM.CA.CH4.TOTAL_SJ_20140718.nc

Methane emission in ktons/year

- In-kind support to Lawrence Berkeley Laboratory in charge of establishing a baseline map of methane emissions in the Bay Area.

- Based on the CALGEM[1] mapping technique developed by LBL.

- Simple model based on a percentage of gas delivery: 0.3% of delivery.

- PG&E provided core customer consumptions aggregated by Zip code.

[1] **CALGEM: California Greenhouse Gas Emissions Measurement Project aims to improve inventory estimates of non-CO2 GHG emissions by performing statistical comparisons of predicted and measured GHG mixing ratios.**
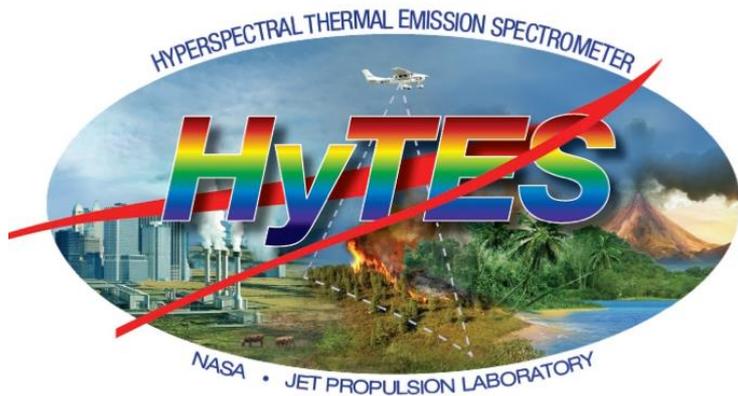http://calgem.lbl.gov/about.html

2015 ▼   Q3 2015

Design | Develop | Test | Deploy

14

Support (No funding by PG&E) to: NASA-JPL to test airborne technologies

CARVE
Carbon in Arctic Reservoirs Vulnerability Experiment

HYPERSPECTRAL THERMAL EMISSION SPECTROMETER
HyTES
NASA • JET PROPULSION LABORATORY

- **In-kind support to NASA-JPL (Jet Propulsion Laboratory) to perform aerial quantification of large methane emissions.**

- **Combination of two techniques developed by NASA-JPL:**
  - Atmospheric methane concentration measurement: CARVE
  - Ground infrared emission measurement above the source location: HYTES

- **PG&E performed controlled releases of natural gas at a regulation station in Bakersfield in February 2015.**

2014

Q3 2015

Design Develop Test Deploy

Support (No funding by PG&E) to: UC Davis to test airborne technologies

Source is within the circles, the aircraft flew in circles from 100 m of altitude to the limit of methane detection

- In-kind support to UC Davis to perform aerial quantification of large methane emissions.

- It is funded by the California Energy Commission through its project: Improvement of an Airborne Natural Gas Leak-Detection System PON CEC-500-13-005.

- Uses Picarro and LGR technologies mounted in an aircraft.

- Includes testing Ethane detector for Natural Gas source identification.

- PG&E performed controlled releases of natural gas at a regulation station at Rio Vista on November 3-4, 2014.

2014   Q3 2015

Design > Develop > Test > Deploy

Thank you

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