Leak Monitoring, Research & Development Advances

Natural Gas STAR/Methane Challenge

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Certified WBENC Women's Business Enterprise

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Companies Heath Works With

Entergy

TransCanada
In business to deliver

Spectra Energy

SOUTHWEST GAS

ENERGY TRANSFER

NW Natural
We grew up here.

conEdison

Williams

IBERDROLA

Atlanta Gas Light
An AGL Resources Company

ONE Gas

QUESTAR Gas

PSE PUGET SOUND ENERGY

UGI
Energy to do more

CenterPoint Energy

Southern California Gas Company

ATMOS energy

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Companies Heath Works With

Sempra Energy

ENBRIDGE

KINDER MORGAN

NiSource

SCANA ENERGY

PSEG

SDGE

Piedmont Natural Gas

New Mexico GAS COMPANY
A TECO ENERGY COMPANY

TECO
AN EMERA COMPANY

PG&E

nationalgrid

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Personal Monitors

- LEL
- Carbon Monoxide
- Hydrogen Sulfide
- Oxygen
- Single Gas
- Multiple Gas
- Automated Calibration Docking Stations

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Combustible Gas Indicators

- Confined Space Monitors
- Volume Gas
- Amplified Catalytic Sensors for PPM
- Semi-conductor for track gas / PPM
- Custom Configurable
- Leak / Odor Investigation tool
- Automated Calibration Docking Stations

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Gasurveyor 700 Series

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Compliance Leak Survey Instruments

- Low level PPM capability
- Volume Gas
- Flame-ionization
- Optical Infrared
- Laser
- Portable
- Vehicle Mounted

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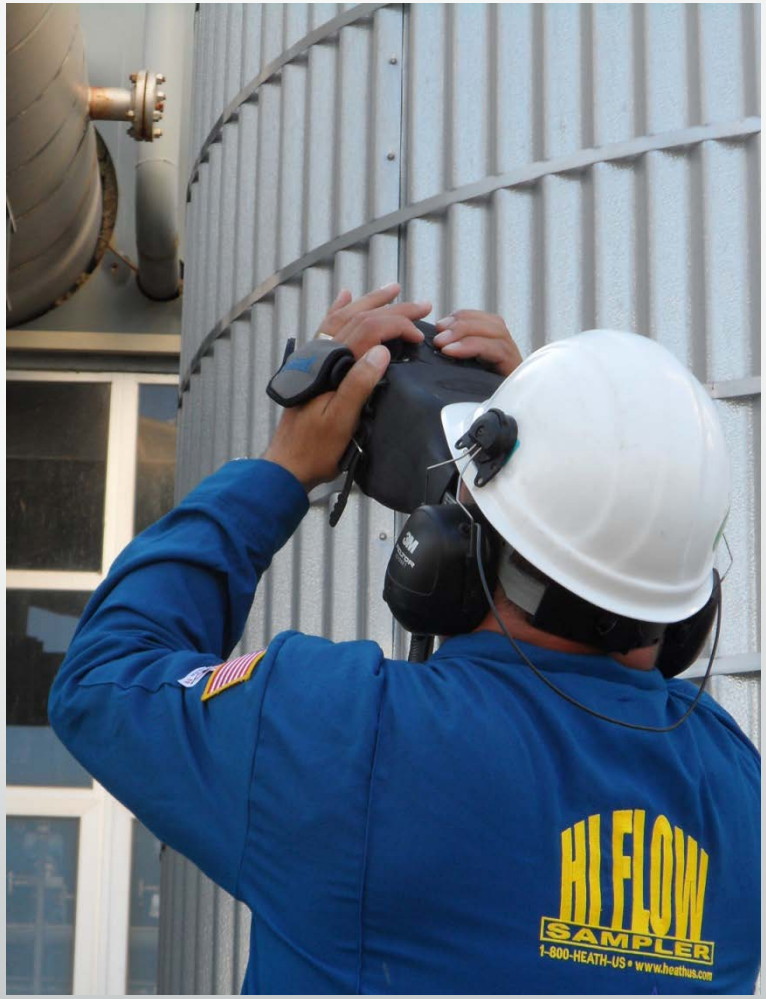
EyeCGas® Infrared Imaging Camera



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RMLD-UAV

- Advanced sUAV suitable for all weather flight
- Auto search, detection, localization and flux quantification
- Methane specific
- Open path bi-static Tunable Diode Laser Absorption Spectroscopy

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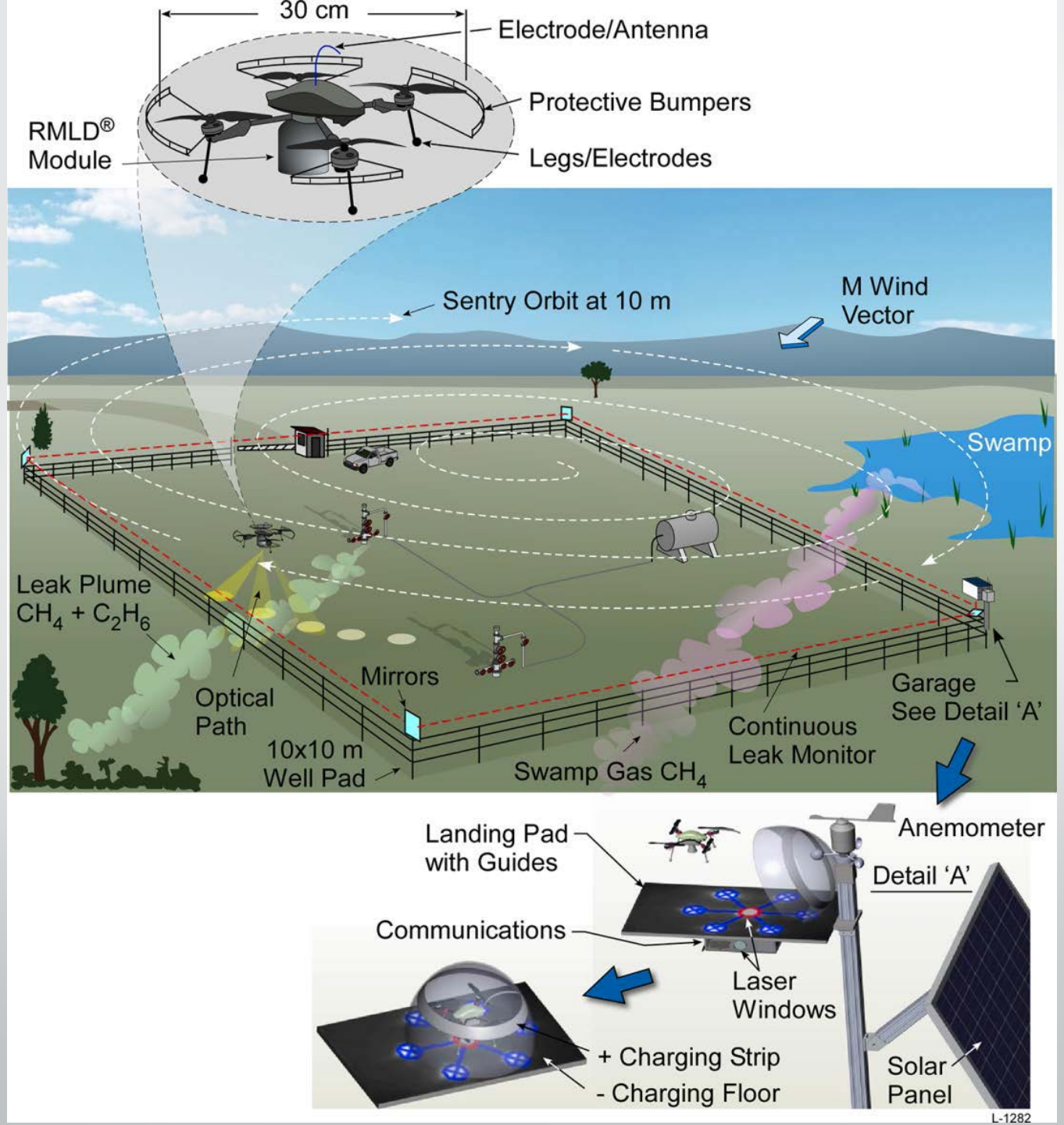

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Portable Standoff Near-IR TDLAS for Leak Survey

PSI
PHYSICAL SCIENCES INC.

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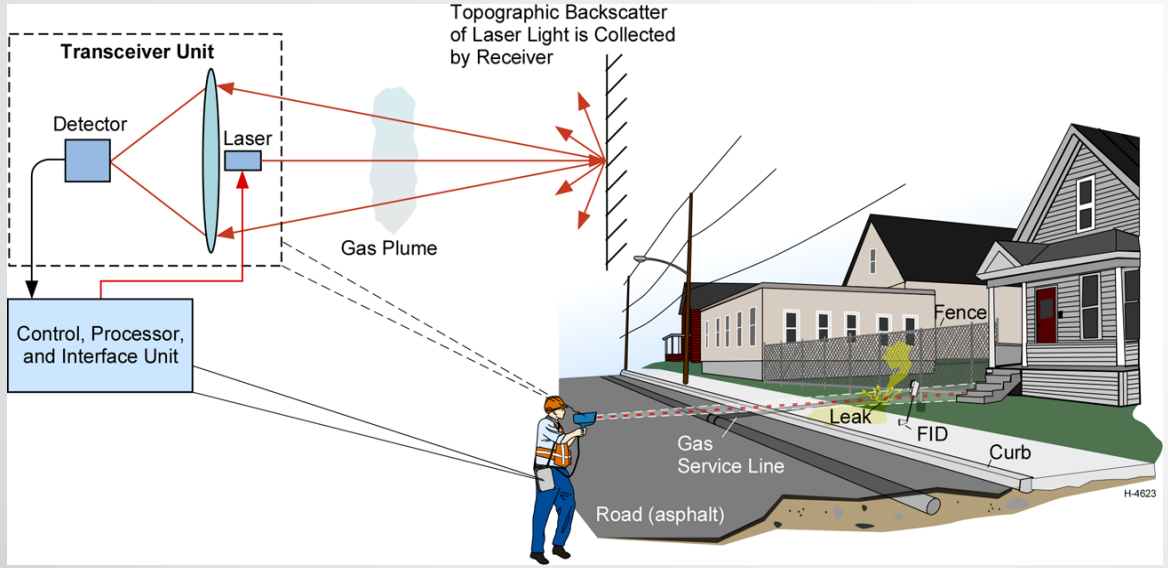
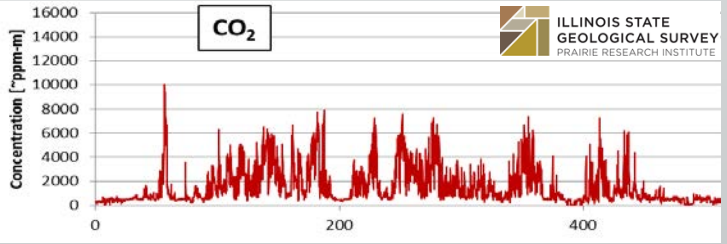


- Laser beam illuminates a distant surface
- Senses analyte gas between transceiver and illuminated surface
  - ***Standoff range ~100 ft with handheld transceiver***
- Scanning laser beam across plume results in rapidly changing analyte gas measurement
- *~2500 RMLDs™ in use for natural gas leak surveying*

Remote Methane Leak Detector (RMLD™)
Commercial product (since 2005)

CO_2 version demonstrated at CCS test site wellhead during maintenance



J.W. Zimmerman, R.A. Locke II, C.S. Blakley, M.B. Frish, M.C. Laderer, R.T. Wainner, "*Initial testing of prototype tunable diode laser absorption spectrometers for CO_2 monitoring applications at the Illinois Basin - Decatur Project*", 13th Annual Carbon Capture, Utilization and Storage Conference, Pittsburgh PA (April 30, 2014)

Open Path Pipeline Monitors

PSI PHYSICAL SCIENCES INC.

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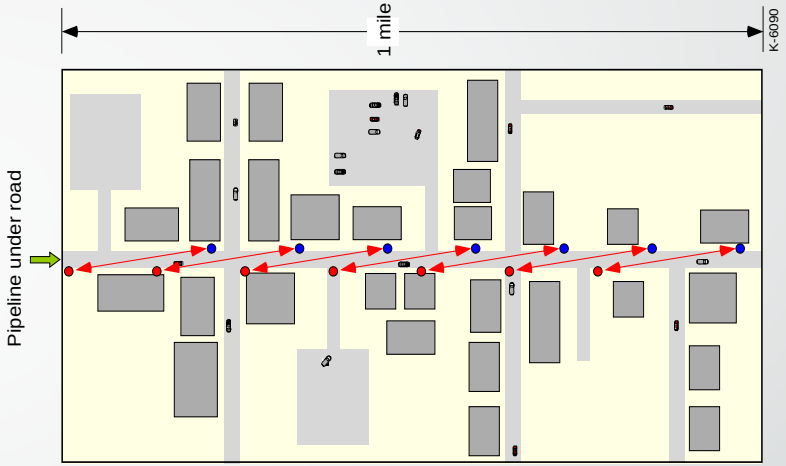
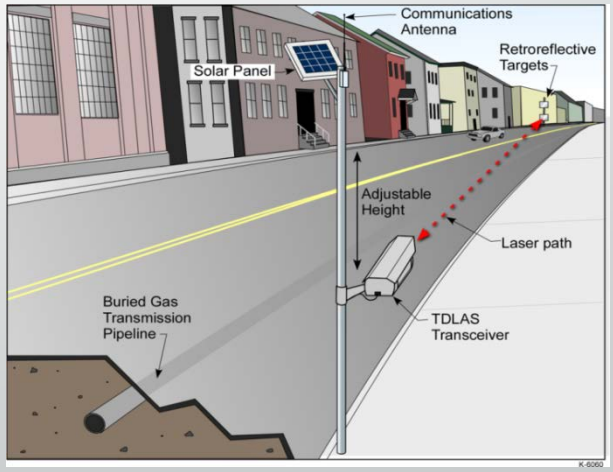
- Permanent laser-based open-path alarms to detect and mitigate small to potentially explosive leaks
  - Wireless, solar-powered
  - Easy installation and alignment
  - Real-time alarm notification
- Operator alert within one minute of urgent leak detection
- Hourly notification of non-urgent leaks, enabling proper operator assessment and response
- Enabled by proven, industry-accepted RMLD™ technology
- CH_4 version demonstrated at PGE Livermore CA Training Center
  - 580' path
  - Months of maintenance-free operation
- CO_2 version tested for more than two years at PSI and Illinois-Basin Decatur Project (IBDP) CCS Site





PG&E

STATE OF CALIFORNIA ENERGY COMMISSION

NETL

ILLINOIS STATE GEOLOGICAL SURVEY PRAIRIE RESEARCH INSTITUTE

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Remote Emissions Monitor (RMLD-REM)

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Network of Methane Sensors

- Leverage existing proven AMI network technology with enabling sensor technology

automated

reliable

low cost

mass market

networked leak detection device

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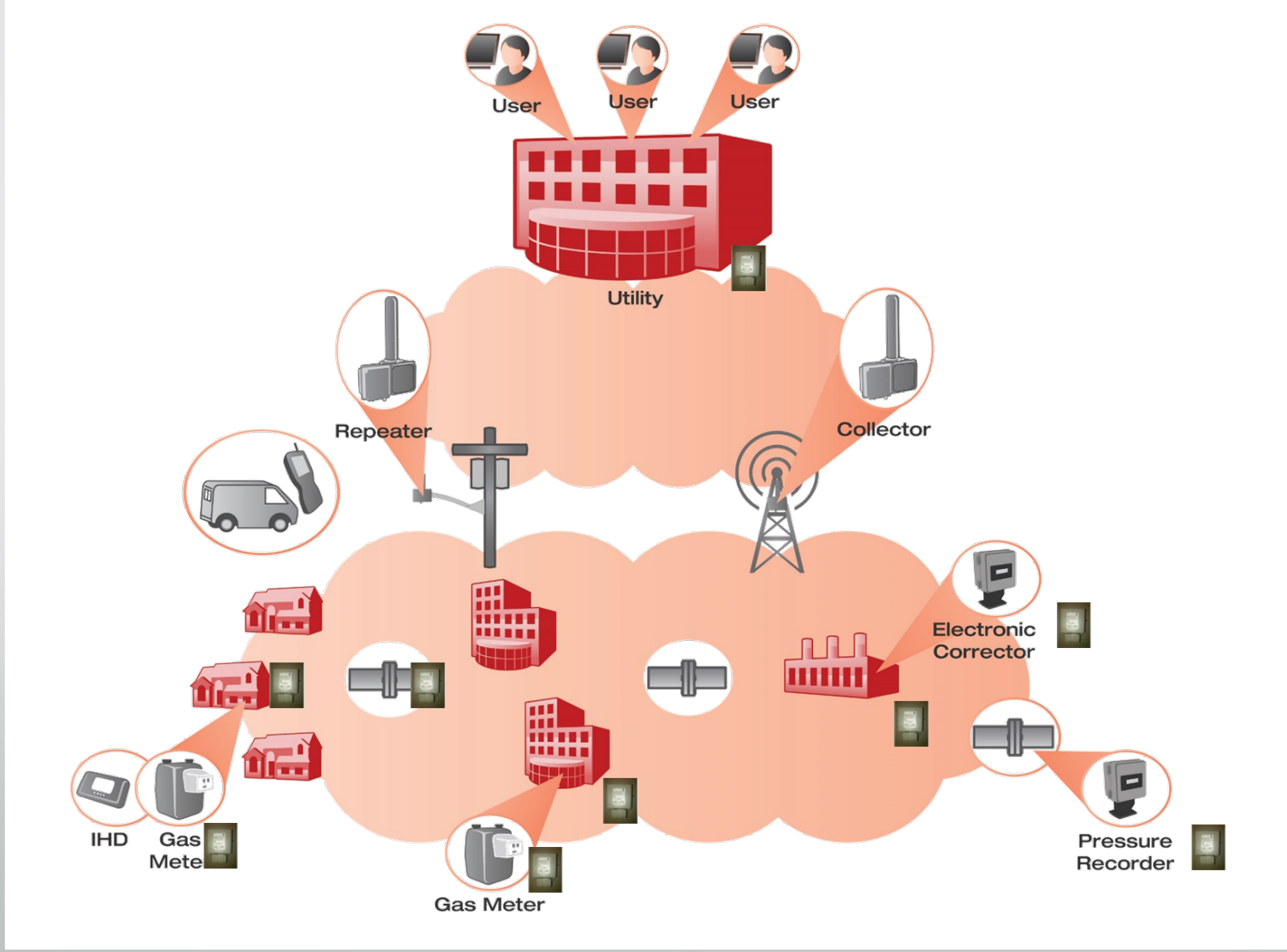
Vision for Gas AMI System



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Layered Gas System Monitoring

- Residential
  - One or more sensor modules placed by meter or indoors
- Distribution system
  - High consequence area monitoring
  - Gate stations
  - Valve enclosures
- Light Industrial
  - Sensor module integrated with a volume corrector or data monitor
- Transmission system
  - High consequence area monitoring

100T-MS Monitor

Refresh Data | Data Source | Display

Devices | Alarms | Readings

Acknowledge | Dispatch | Resolve | Clear

Date/Time	Device ID	Premise	Address	CH4 %LEL	Prior CH4 %LEL	Severity	Status
4/18/2012 11:03 AM	39399766	Residence	640 5th St Safetown, MN 56093	33.6	4.5	LEVEL CRIT	NEW
4/17/2012 2:08 PM	39399766	Residence	640 5th St Safetown, MN 56093	34.1	4.8	LEVEL CRIT	RESOLVED
4/17/2012 10:09 AM	39399766	Residence	640 5th St Safetown, MN 56093	25	1.4	LEVEL CRIT	DISPATCHED
4/16/2012 4:25 PM	39399766	Residence	640 5th St Safetown, MN 56093	20.1	1.8	LEVEL CRIT	RESOLVED
4/16/2012 4:17 PM	39399766	Residence	640 5th St Safetown, MN 56093	28.7	4.6	LEVEL CRIT	CLEARED
4/16/2012 2:42 PM	39399766	Residence	640 5th St Safetown, MN 56093	28.7	4.7	LEVEL CRIT	CLEARED
4/16/2012 2:37 PM	39399766	Residence	640 5th St Safetown, MN 56093	21.1	4.5	LEVEL CRIT	CLEARED
4/16/2012 1:46 PM	39399766	Residence	640 5th St Safetown, MN 56093	25	1.3	LEVEL CRIT	RESOLVED
4/16/2012 12:05 PM	39399766	Residence	640 5th St Safetown, MN 56093	32.1	3.2	LEVEL CRIT	RESOLVED
4/13/2012 3:10 PM	39399766	Residence	640 5th St Safetown, MN 56093	32.5	1	LEVEL CRIT	CLEARED
4/13/2012 3:03 PM	39399766	Residence	640 5th St Safetown, MN 56093	20.3	0.8	LEVEL CRIT	RESOLVED
4/13/2012 2:44 PM	39399766	Residence	640 5th St Safetown, MN 56093	35.3	2	LEVEL CRIT	DISPATCHED
4/13/2012 2:31 PM	39399766	Residence	640 5th St Safetown, MN 56093	30.2	4.2	LEVEL CRIT	DISPATCHED
4/13/2012 2:28 PM	39399472	Residence	670 3rd St Safetown, MN 56093	34	4.5	LEVEL CRIT	DISPATCHED
4/13/2012 2:26 PM	39399766	Residence	640 5th St Safetown, MN 56093	35.2	4.1	LEVEL CRIT	RESOLVED
4/13/2012 2:25 PM	39399766	Residence	640 5th St Safetown, MN 56093	33.9	2.9	LEVEL CRIT	CLEARED
4/13/2012 2:24 PM	39399766	Residence	640 5th St Safetown, MN 56093	27.5	1.9	LEVEL CRIT	CLEARED
4/12/2012 12:21 PM	39399766	Residence	640 5th St Safetown, MN 56093	23.2	1.2	LEVEL CRIT	CLEARED
4/12/2012 12:21 PM	39399766	Residence	640 5th St Safetown, MN 56093	33.1	4.3	LEVEL CRIT	NEW
4/12/2012 12:21 PM	39399766	Residence	640 5th St Safetown, MN 56093	22	4.3	LEVEL CRIT	NEW
4/12/2012 12:19 PM	39399766	Residence	640 5th St Safetown, MN 56093	31.8	26.9	LEVEL CRIT	NEW
4/12/2012 12:18 PM	39399766	Residence	640 5th St Safetown, MN 56093	21.1	35.7	LEVEL CRIT	NEW
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4/12/2012 12:03 PM	39399766	Residence	640 5th St Safetown, MN 56093	22.3	27.3	LEVEL CRIT	NEW
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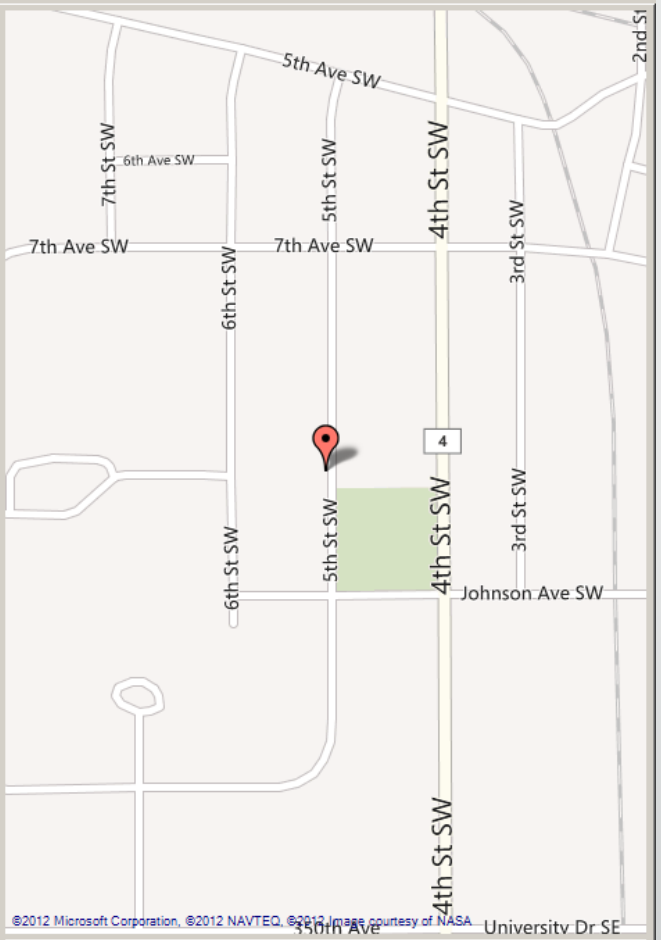
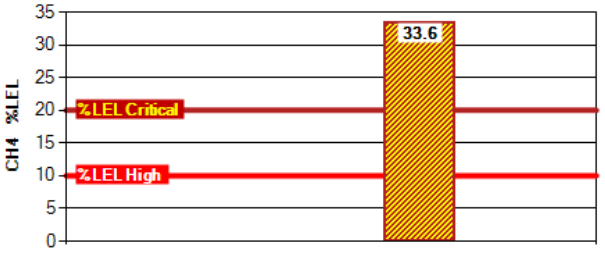
4/10/2012 8:42 AM	39399766	Residence	640 5th St Safetown, MN 56093	171.5	1186.9	TEMP OOR	CLEARED
4/9/2012 4:07 PM	39399766	Residence	640 5th St Safetown, MN 56093	171.5	1186.9	TEMP OOR	CLEARED





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Methane Sensor Monitor

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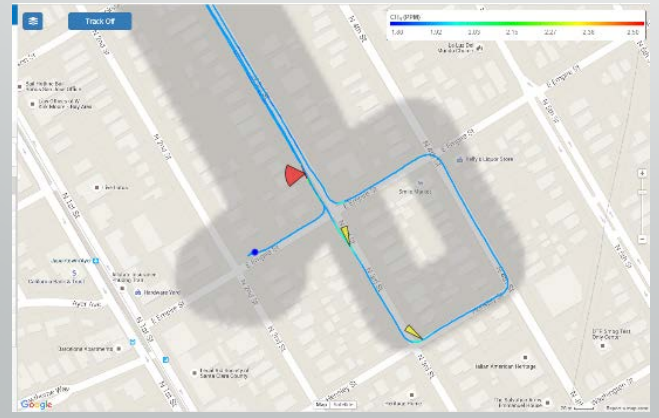
MobileGuard

Ultra Sensitive Mobile Monitoring



- **High sensitivity sensor**
  - Parts per billion (ppb)
  - Instantaneous response
- **Mobile Platform**
  - Geo-located measurements
  - Survey quickly and efficiently
  - Simple configuration (easy install)
- **Leak Detection Software**
  - Easy to use interface
  - Real-time plotting of leak Indications
  - Real-time gas discrimination
  - GIS compatible

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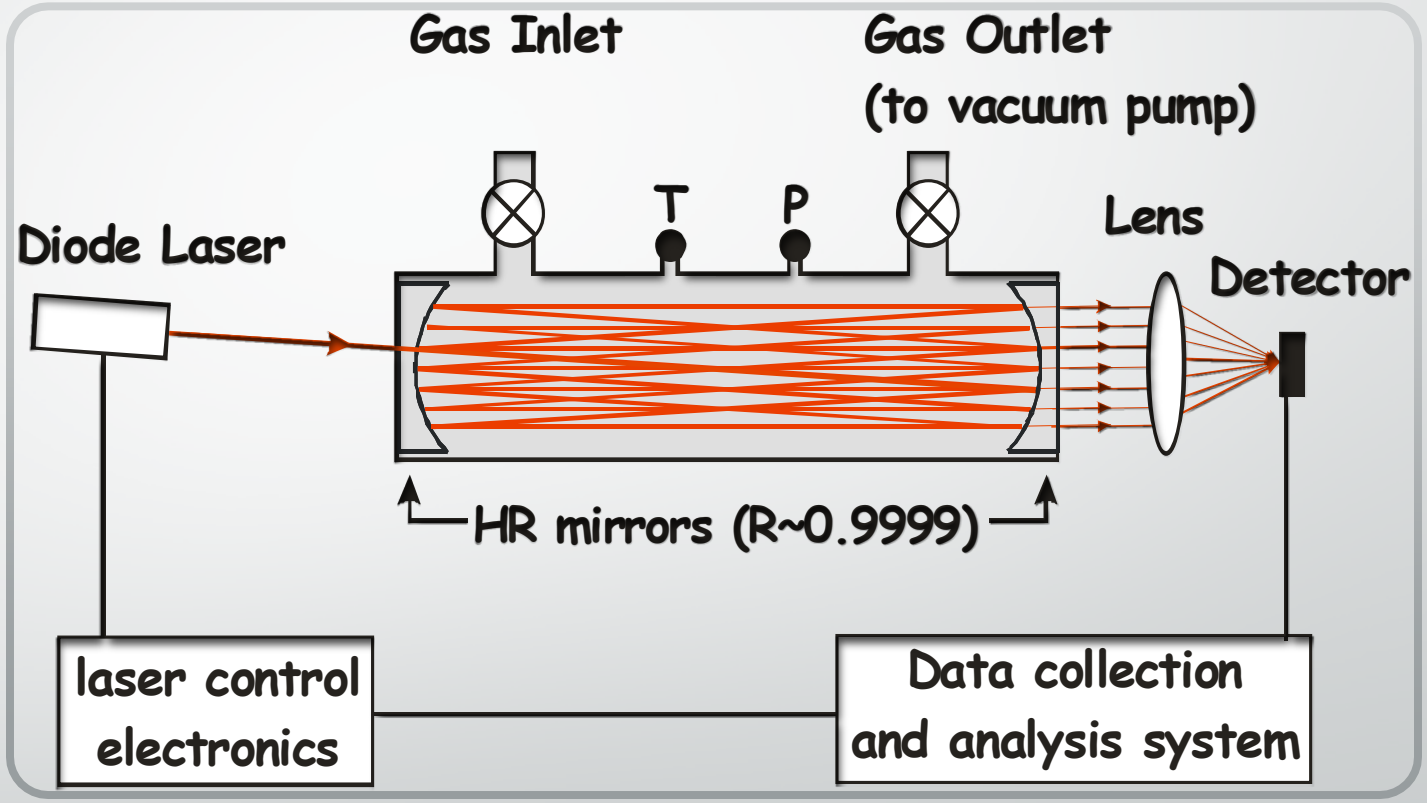
Development of Next Generation Mobile Monitoring

- Vehicle-mounted sensors have a long history and have been extensively vetted - Developed in 1995 have
- Gone from legacy Cavity Ringdown to OA-ICOS
- Started mobile survey use and perfecting survey methodology since 2010
- Allows for cost-effective surveys of large areas at a rapid pace
- Requires:
  - Manufacturable, easy-to-use gas sensors that do not require researchers
  - Complete sensor suite - sensor, GPS, anemometer, gas inlet…
  - Leak detection software – analysis interpretation, leak aggregation
  - Data presentation user interface

MobileGuard Technology

Patented Off-Axis ICOS (OA-ICOS)

- Patented 4th generation cavity-enhanced technique
- Optical path provides very long pathlength
- Increased dynamic range
- Very robust – exact alignment is not critical, enabling mobile monitoring
- All advantages of conventional TDLAS, with increased sensitivity (ppb) and dynamic range



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MobileGuard Solution

MEA for Mobile Monitoring

Mechanical Features

- 19” rack compatible
- 4U High (7”)
- 12 VDC
- Integrated Pump
- Integrated GPS Receiver
- Water Trap
- Humidity Interlock

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Vehicle Integration

Off-Axis ICOS Analyzer
(Methane/Ethane)

GPS
(Location)

Sonic Anemometer
(Wind Speed/Direction)

Computing
(Leak Detection Software)

Methane, location and wind speed are analyzed by the computer to create leak indications

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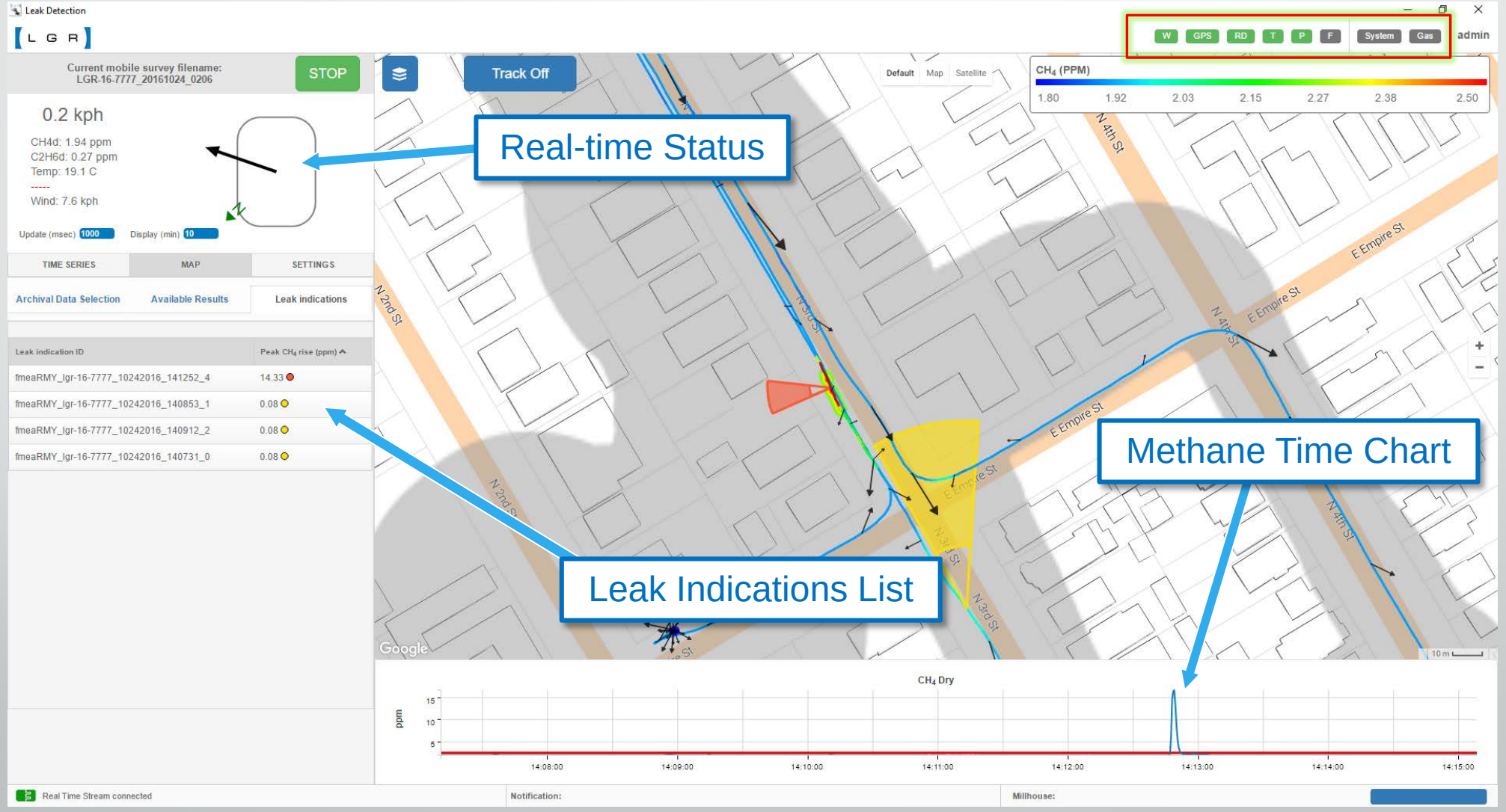
User Interface

Measured Data and Automated Alarms



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Drive Reports
Available Formats

PDF

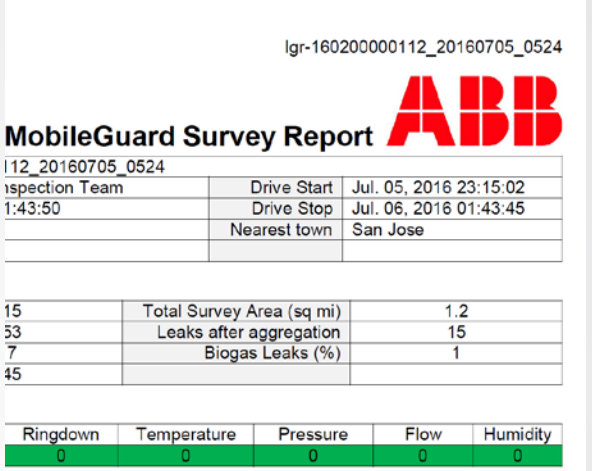
- Printable, static file
- Universally sharable

KMZ/KML

- View in Google Earth
- Import layers into GIS

Proprietary XML

- Machine readable
- Database import



lgr-160200000112_20160705_0524

MobileGuard Survey Report

112_20160705_0524		
nspection Team	Drive Start	Jul. 05, 2016 23:15:02
1:43:50	Drive Stop	Jul. 06, 2016 01:43:45
	Nearest town	San Jose

15	Total Survey Area (sq mi)	1.2
53	Leaks after aggregation	15
7	Biogas Leaks (%)	1
45		

Ringdown	Temperature	Pressure	Flow	Humidity
0	0	0	0	0

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QUESTIONS?

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