



Driving Innovation ♦ Delivering Results



NETL's Natural Gas Midstream Research Program

**Methane Emissions from California's Natural
Gas System: Challenges and Solutions**
June 6, Sacramento, CA

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U.S. DEPARTMENT OF
ENERGY

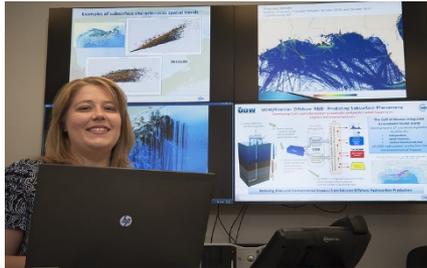
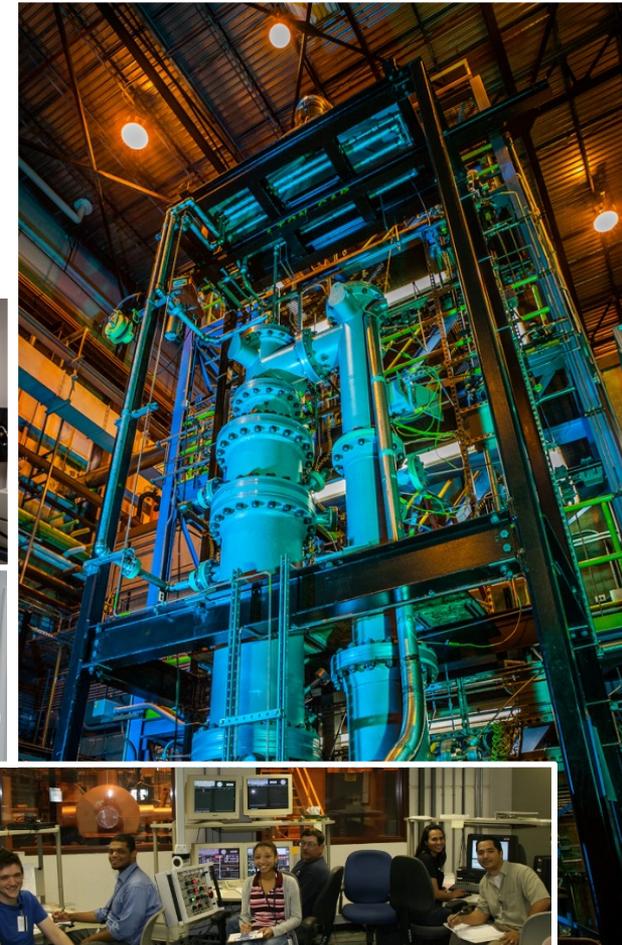
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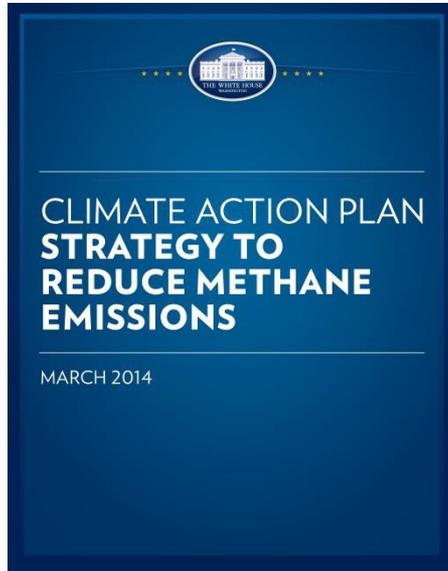
NETL is....



the Nation's Fossil Energy National Laboratory

- 1,350 employees
 - Internationally Recognized Expertise in Fossil Energy
- Three R&D laboratories in OR, PA, and WV
 - World Class Facilities Designed to Address FE Issues
- FY2016 budget of \$896M
 - 1,400 R&D projects/50 states





President's Climate Action Plan

“Curbing emissions of **methane** is critical to our overall effort to address global climate change. ... To achieve additional progress, the Administration will”:

- Develop a comprehensive Interagency Methane Strategy **(completed March 2014)**
- Pursue a collaborative approach with state governments and the private sector and cover all methane emitting sectors
- Meet a 2025 target for the O&G sector to reduce methane emissions by 40 to 45% below 2012 levels (established January 2015)

Interagency Methane Strategy – Three Pillars

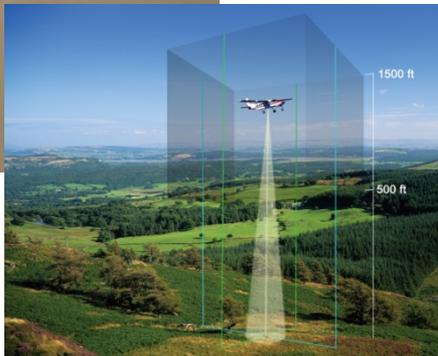
Assessing Current Emissions Data and Addressing Data Gaps

Identifying Technologies and Best Practices for Reducing Emissions

Identifying Existing Authorities and Incentive-based Opportunities for Reducing Emissions



- Six year program accelerated technology development and created a platform for continued R&D by DoT and industry
- Conducted large scale, blind demonstrations of emerging technologies for leak detection and pipeline inspection sensors
- Technologies taken to commercialization:
 - Aerial gas leak detection – Airborne Natural Gas Emission Lidar (ANGEL)
 - Mobile remote methane leak detection system
 - Explorer II pipeline inspection robot for un-piggable pipes
 - Timberline Tool keyhole squeeze off tool for large diameter PE pipe and keyhole external repair tool (thermoplastic patch) for damaged PE pipe



Scientifically quantify emissions:

- Limited number of high quality field data sets representative of shale gas operations
- Identify and improve source measurements **in the field** (six projects)
- Improve atmospheric measurements and modeling estimates



Current Emissions Field Projects Matrix



Project	Location	Source	Emissions Data	Platform	Primary Product
Penn State	Marcellus, NE PA	Gas Production Agriculture Landfills Wetlands	<i>Methane</i>	Aircraft Tower Vehicle	Tops-down, Bottom-up Reconciliation
Carnegie Mellon	Marcellus, SW PA	Gas Production Agriculture Landfills Coal Activities	<i>Methane</i> VOCs	Vehicle	Source Apportionment
West Virginia	Marcellus, N WV	Well Pad Engine Operations	<i>Methane</i> CO2	Portable Field Stations	CH4 Inventory
NETL	Marcellus, SW PA	Well Pad - lifetime	<i>Methane</i> CO2 VOCs NOx	Mobile Trailer	Lifetime Evaluation
Utah State	Uinta Basin, NE UT	Water Ponds Land Farms Natural Seepage Soils Near Wells	<i>Methane</i> CO2 VOCs	Portable Field Stations	Predictive Models
Colorado School of Mines	Mid-continent Basin	All area sources	<i>Methane</i> VOCs	Aircraft Tower Vehicle	Tops-down, Bottom-up Reconciliation

NETL's Assessment of Shale Gas Development's Air Quality Impacts



Ambient Air Monitoring:

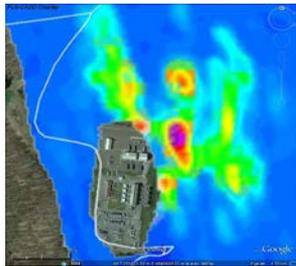


NETL's Mobile Air Monitoring Laboratory

Emissions of methane, volatile organic compounds, particulate matter, reactive nitrogen, carbon dioxide



Helicopter- and vehicle-based methane surveys:



Aerial Detection of Methane from a compressor station

Methane Emissions from Abandoned Wells:

Methods development and measurements using multiple techniques (direct flow rate measurements, dynamic flux chamber, infrared camera, bagged samples)



Problem: Uncertain/inaccurate values for emission factors associated with large contributors to life-cycle emissions

Objectives:

- To collect field data of representative ambient and point source air emissions
- To use collected data coupled with atmospheric chemistry and transport models to inform emission factor development/improvement



Natural Gas Pipeline Leak Detection and Quantification:

UTV-based surveys to locate pipeline, find leaks, and measure leak rate

Protocol Development for Reconciling Basin-Scale Top-Down and Bottom-Up Methane Emissions



- Compare methane emissions estimates from NG sources at basin and facility level
- Extensive sampling campaign in mid-continent basin in fall 2015 - Over 230 NG facilities measured
- Preliminary results -
 - Fat tail observed
 - Measurements PLUS on-site observer and industry activity data are critical for proper interpretation of measurements and emission estimation

Key Project Feature	This study	EDF Barnett
Industry activity data	✓	✗
Site access	✓	✗
Statistically representative sampling	✓	✗
Multiple methods tested simultaneously	✓	✗
Measurements made within field campaign in basin	✗	✗
Measurements from all value chain segments	✓	✗
Measurements of non-O&G sources	✓	✗

≈All
 None or very little
 Some, not all

Key Performers: Colorado School of Mines, NOAA

New FY16 Initiatives

Expanding Methane Quantification Program



Mission

Improve the quantification of methane emissions across the natural gas value chain
Inform EPA's Greenhouse Gas Inventory

Investment

\$5 Million in 2016, \$5 Million planned for 2017

Research Elements

Legacy infrastructure emissions characterization



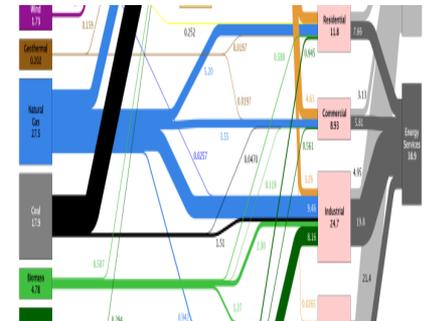
Gathering, compressor, and distribution systems emissions characterization



Underground natural gas storage emissions quantification and analysis



Enhanced analysis



Partners

Industry, National Labs, Universities

New FY16 Initiatives

Initiate Methane Emissions Mitigation Program



Mission

Develop new technologies to reduce methane emissions from midstream infrastructure to enhance the efficiency of natural gas delivery in the United States.

Investment

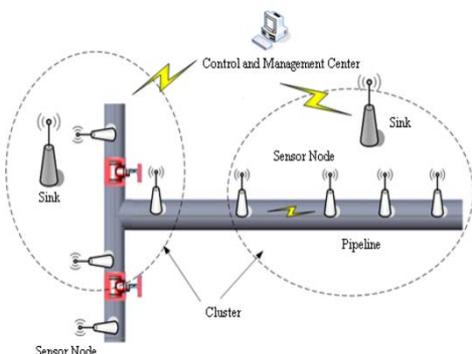
\$7 Million in 2016, \$6 Million planned for 2017

Research Elements

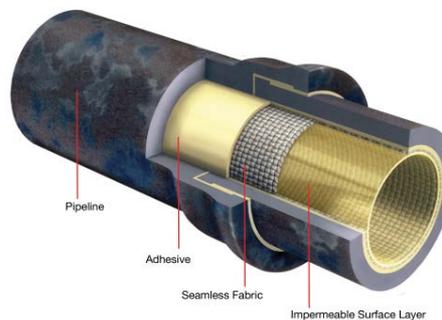
Develop advanced equipment technologies



Develop and test advanced sensors to communicate operational data and pipeline properties



Develop and test next generation pipeline liners and coatings



Pipeline inspection and repair w/o emissions



Partners

Industry, National Labs, Universities

Methane Emissions Mitigation and Quantification from Natural Gas Infrastructure

Opened - April 13, 2016; Closes - June 13; Awards – September

Methane Emissions Mitigation (Relevant to Operational Environment)

- A. Pipeline Inspection and Repair (eliminate venting prior to maintenance or repair)
- B. Smart Pipeline Sensors (continuous, in pipe sensing of operational parameters)
- C. Advanced Equipment Technologies (compressor seals, pneumatic controllers, etc.)

Methane Emissions Quantification (EPA Priorities)

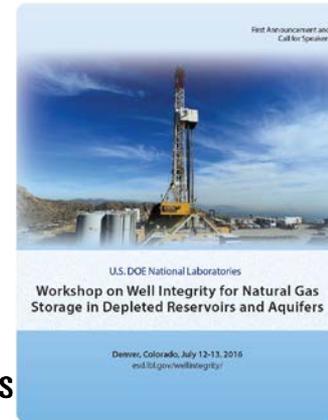
- A. Gathering System Pipeline and Compressor Characterization
- B. Distribution System Characterization (pipe type, industrial meters)
- C. Underground Natural Gas Storage Emissions (quantification and leak frequency of storage wells/fields)



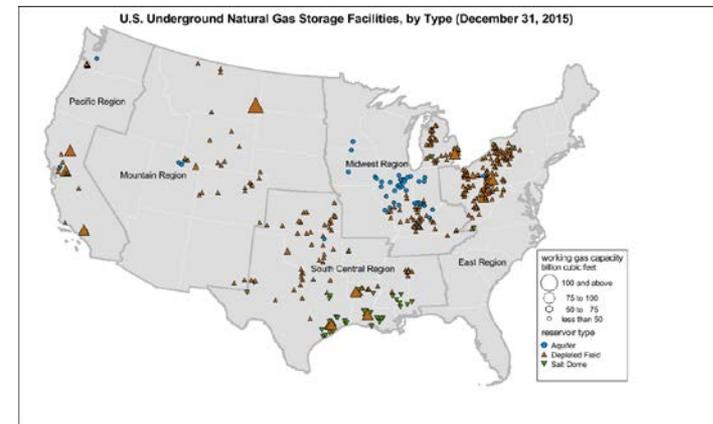
Natural Gas Storage Task Force – Wellbore Integrity Lab Team

- **Multilab team focusing on wellbore integrity for gas storage**
- **Organizing a workshop on natural gas storage wellbore integrity**
 - Denver, CO on July 12-13
 - Gathering technical input on the state of technology
 - Coordinating with PHMSA (workshop on July 14)
- **Main Team Tasks**
 - Analysis of event at Aliso Canyon and associated circumstances
 - Build off of what was done by CA lab team
 - Evaluation of potential issues at natural gas storage sites nationwide
 - Gather data on the state of natural gas storage wells
 - Revisit recent incidents beyond Aliso
 - Generate a publicly available report
 - Recommendations for safe practices for wellbore integrity
 - Recommendations for monitoring practices
- **Wellbore integrity task force work intended to be complete by the end of September**

Technical Team



esd.lbl.gov/wellintegrity

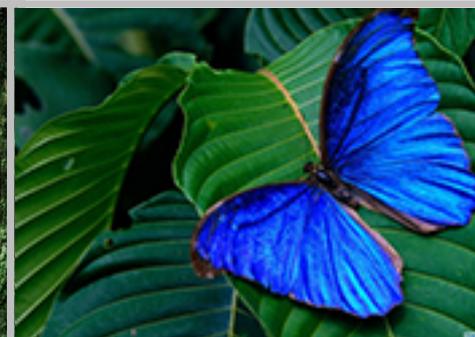


EIA, 2016.



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