Emerging Technologies for Reduction of Fugitive Methane Emissions

Dr. Bryan Willson
Program Director
ARPA-E, U.S. Dept. of Energy
Advanced Research Projects Agency - Energy

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Key Points

1. CH$_4$ emissions from oil & gas comprise 2.5%-8+% of U.S. GHG production – based on time frame for GWP analysis

2. Significant variability between bottom-up and top-down measurements

3. Roughly 50% of fugitive emissions are from leaks (which require measurement solutions) and 50% from known sources (which require mitigation solutions)

4. New technologies are emerging for both measurement & mitigation, but the business / regulatory drivers are unclear
Contribution of Oil & Gas Production to U.S. GHG Emissions? It Depends...

\[ \text{GWP}_{100} \text{ of 21 gives 2.6\%, } \text{GWP}_{100} \text{ of 25 gives 3.1\%} \]
\[ \text{GWP}_{20} \text{ of 72 gives 7.4\%, } \text{GWP}_{20} \text{ of 82 gives 8.2\%} \]


U.S. Methane Emissions, By Source

2011 data, released by EPA in April 2013
www.epa.gov/climatechange/ghgemissions/gases.html
Range of Leakage Estimates
Do not match atmospheric measurements

Based on atmospheric measurements

“Bottom-up” estimates

Always lower GH forcing than coal
Vehicle Equivalence

- Current NG leakage estimates: 1.5%-10+% of production
- Methane reduction of:
  - 1%* ≈ elimination of 82 million vehicles**
  - 3% ≈ elimination of 245 million vehicles, 110% of US vehicle population**

*percentage point reduction, i.e. from 3.0% loss to 2.0%
**based on 20-yr GWP of 72
Natural Gas System Consists of Millions of Sources

2.7 million wells
900,000 active wells
500,000 gas wells
400,000 oil wells
40,000+ new wells annually
1.8 million abandoned wells

200,000 Miles of gathering pipe (typically 8-5/8” or less)
500 psi

1,500 Compressor stations for transmission
- 7,500 engines
- 1,500 turbines
- 50 million hp
- 37.5 gW

6,300 production companies
21 major production companies

400 Underground storage facilities

320,000 Miles of large dia transmission pipe
24”-48”
1,000 psi

1,700 natural gas-fired power plants

1,8 million abandoned wells

62 million homes with natural gas in U.S.

580 natural gas processing plants

1,000 psi

2.1 million Miles of distribution pipe

500 psi

620 million homes with natural gas in U.S.

http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=E_ERTW0_XWC0_NUS_C&f=A
http://primis.phmsa.dot.gov/comm/PipelineBasic

Text from AGA & supplemental sources
Emissions are Dominated by Small % of Sources
Pareto distribution: 20% of sources $\rightarrow$ 80% of methane loss
≈50% of CH\textsubscript{4} emissions require sensing
≈50% of require sensing operation changes

Sources: EPA (pg. 5-6), EPA
Plugged, Abandoned, & Orphan Wells

- ≈1 million oil & gas wells in production
- ≈1.8 million wells have been abandoned – location known for less than half (?), 184,000 unknown in PA alone
- States have located 60,000 wells that need to be plugged – could be 300,000 – 1,000,000+*

*Sources propose “probably many times higher”
Enabling Technologies - Sensing

State-of-the-Art: Tunable mid-IR laser spectrometry with cryogenic sensors,
$50K for single point measurement
$100K for imaging camera (i.e. FLIR)

New Technologies:

- Potential for dramatic reductions in mid-IR lasers
- Sensor-on-a-chip technology for sampling cells
- Non-cryogenic plasmonic detectors
- Potential for dramatic reductions in:
  - Single-point sensor cost
  - Imaging sensor cost
- Platform technologies include mobile measurement & UAVs for very low cost sampling
Emerging Technologies - Mitigation

- Reduced emissions completions underway, now guaranteed by NSPS
- Plunger lifts now becoming common for liquids unloading
- Solutions possible for:
  - Vapor recovery units
  - Gas pneumatics
  - Tanks & hatches
  - Enhanced monitoring
- Wellpads remain underpowered – more focus needed for on-site power generation
  - Grid connection viewed as a vulnerability
  - Need high-reliability natural gas generators
  - Options include: Stirling, thermoelectric, 2-str or 4-str IC engines, solid oxide fuel cell, etc.
  - Would allow greater utilization of VRU
  - Air pneumatics would replace gas pneumatics
  - Monitoring is no longer a power problem
Flaring – What else can we do with the gas?

Potential Solutions

‣ Power generation & export
‣ Gas-to-Liquids (ARPA-E: current projects & upcoming REMOTE program)
‣ Compression & liquefaction for natural gas vehicles

Challenge

‣ “Stranded gas” is viewed as a transient problem, that declines as pipeline capacity comes online
‣ “Transient” scenario is an obstacle for investment
The Business Challenge

- Once the “easy fixes” are complete, methane reduction has a lower ROI than investment in new production
- Even with good ROI, companies are personnel-constrained
- Natural gas prices still low, reducing economic motivation to reduce product loss
- No economic driver for GHG reduction
- Few regulatory drivers

Co-benefits

- Reduction of VOCs & ozone