

Oil and Gas Methane Emissions: Impacts, Sources, and Solutions

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Edmonton Canada, September 9, 2015



Visualizing Unseen Methane



Climate Implications of Methane

POUND FOR POUND METHANE TRAPS

84X MORE HEAT OVER 20 YEARS

CO₂

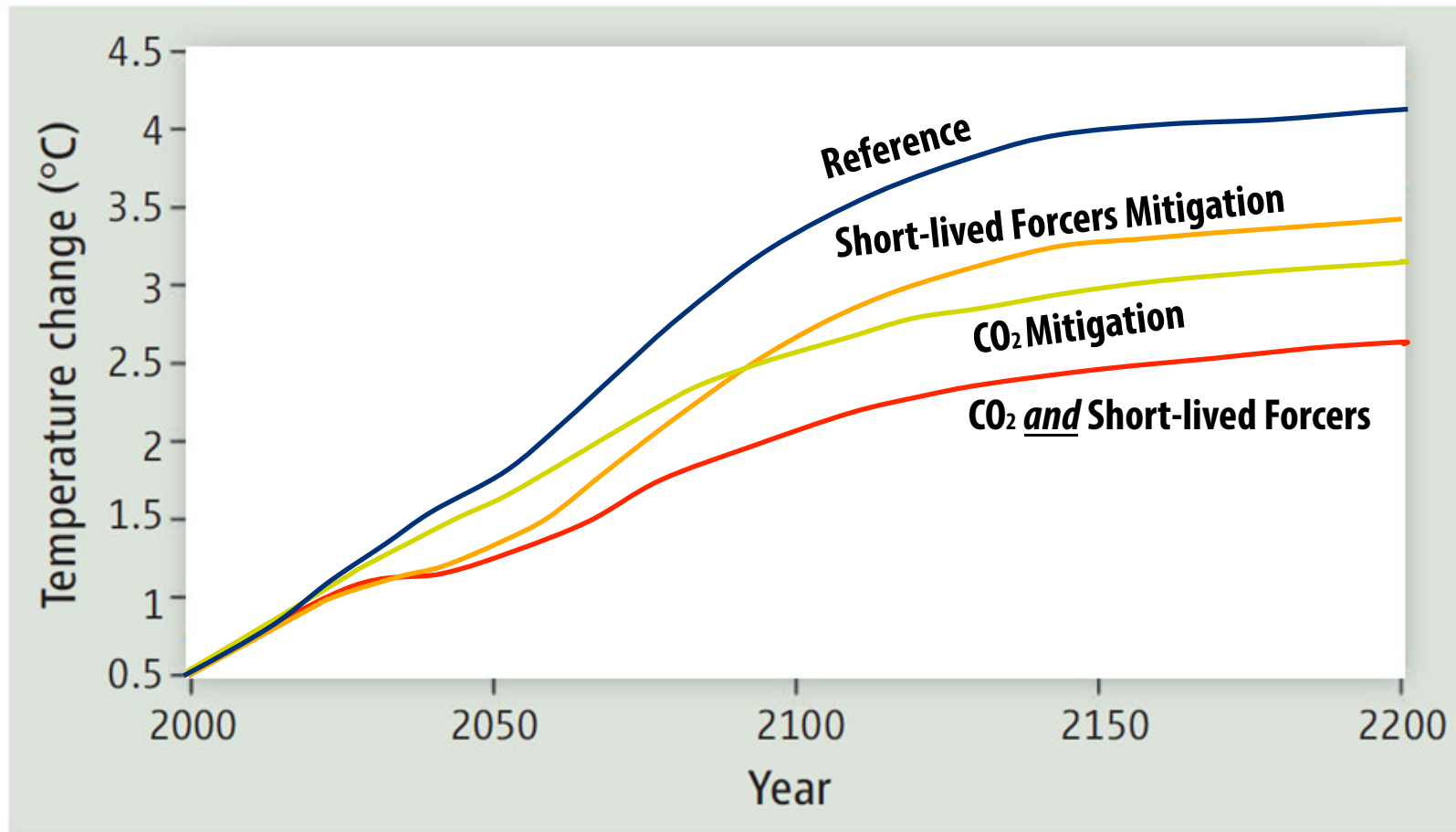


CH₄

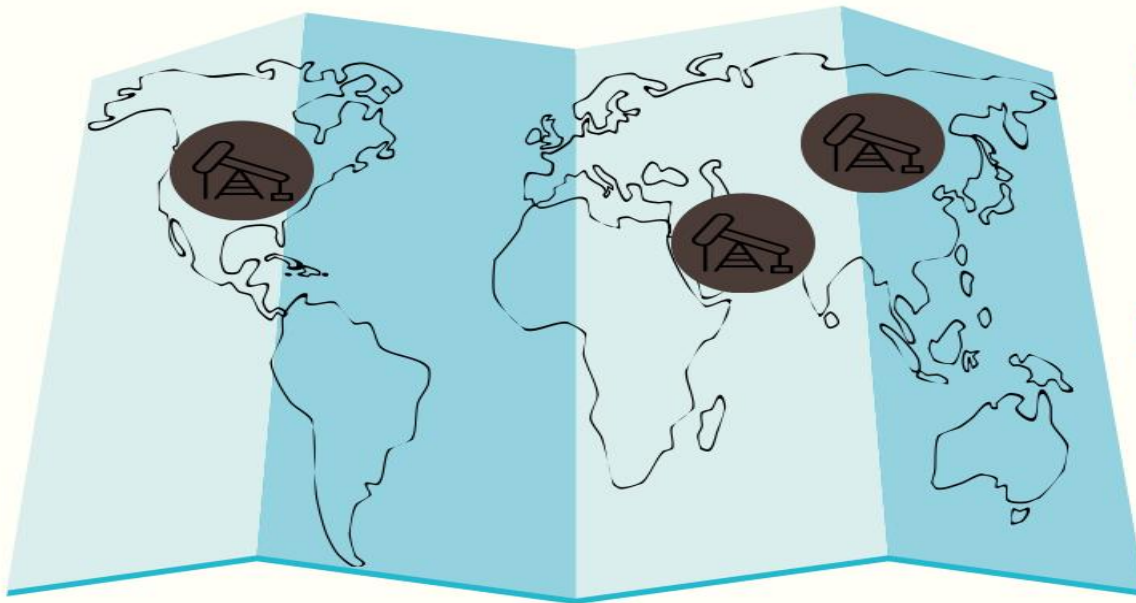


About **25 percent** of the man-made warming we are experiencing today is caused by methane.


Reduce Methane *and* CO₂



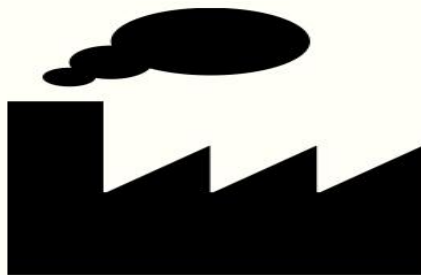
GLOBAL OIL AND GAS METHANE EMISSIONS



 **Top 30 Countries Account for 75% of Emissions**

 **Wasted Gas Equals Norway's Production, 7th Largest Producer**

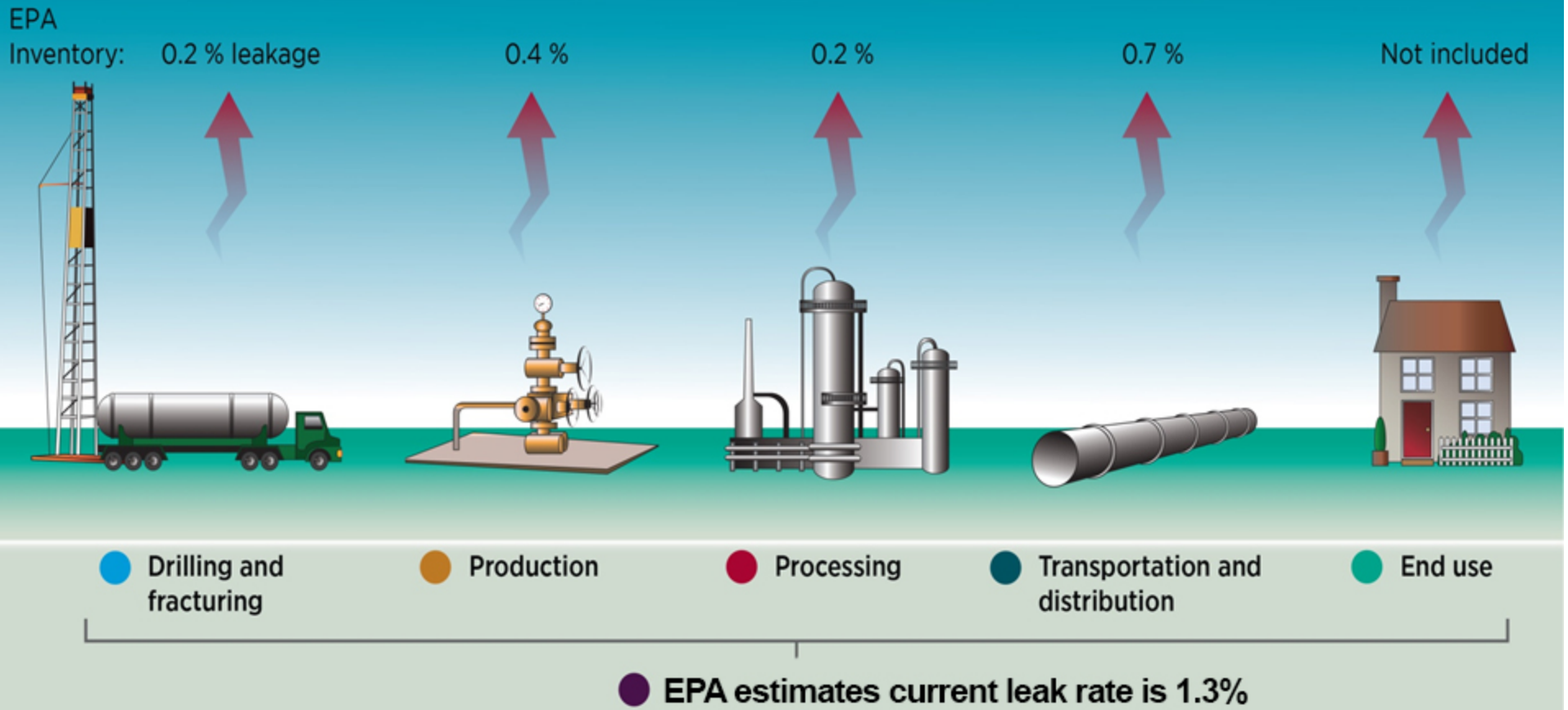
 **Lost Revenue of \$30 Billion**



Oil and Gas Methane Emissions Equivalent to 40% of Global CO₂ Combustion

Rhodium Group analysis, available at: www.edf.org/globalmethane

United States Methane Leakage Rates from the Natural Gas System



Evidence from other Studies

- ● Nationwide, NGML/EPA, 2006 ↔
- Nationwide, GTI, 2009 ↔
- ● Los Angeles, CARB/UC Irvine/NOAA, 2010 ↑
- Texas & New Mexico, URS/U. Texas, 2011 ↔
- ● Colorado, NOAA, 2012 ↑

- ● Los Angeles, Caltech, 2012 ↑
- Nationwide, Harvard, 2013 ↑
- Los Angeles, CU Boulder, 2013 ↑
- ● Utah, NOAA, 2013 ↑
- ● Nationwide, U. Texas, 2013 ↔

LEGEND

Study title indicates location, organization(s) that conducted study, and year of study

- ↑ Emissions higher than EPA
- ↓ Emissions lower than EPA
- ↔ Mixed results relative to EPA

Even 1.3% Leakage is Too High...



**Equal to GHG emissions
of 117 million cars (50% of US Cars)**

OR



**141 Coal-fired Power Plants
(35% of US Coal Plants)**



**Equal to gas carried by
LNG 127 tankers**



**\$1.7 to 6.2 billion
in lost revenue**

Using 20 year GWP of 86

EDF CATALYZING MORE SCIENCE

PRODUCTION

GATHERING/PROCESSING

TRANSMISSION/STORAGE

LOCAL DISTRIBUTION

TRUCKS AND STATIONS



★ 1. NOAA Denver-Julesberg

★ 2. NOAA Barnett

★ 3. Coordinated Campaign (13 papers)

★ 4. UT Phase 1

★ 5. UT Phase 2

★ Pneumatics

★ Liquid Unloadings

★ 6. HARC/EPA

★ 7. CSU Study

★ Methods Paper

★ Measurement Paper

★ • Modeling Paper

★ 8. CSU Study

★ Measurement Paper

★ • Modeling Paper

★

★ 9. Methane Mapping

★ 13. WVU Study

★ 10. Boston Study

★ 11. WSU Multi-City

✗ 12. Indianapolis Study

★ 14. Pilot Projects

▲ 15. Gap Filling

✗ 16. Project Synthesis

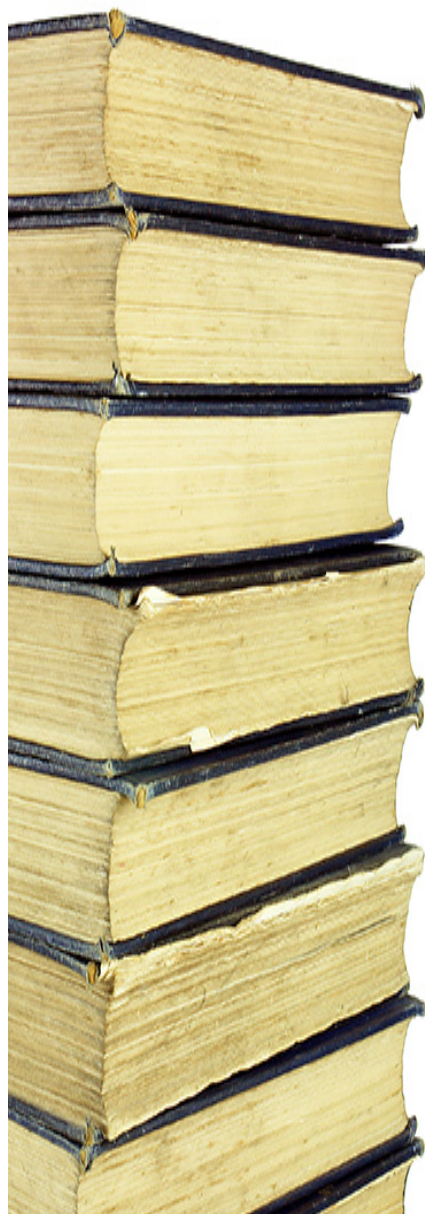
★ Results public

★ Submitted, not yet public

▲ Almost ready for submission


✗ Not yet submitted

24 Published Studies Thus Far...

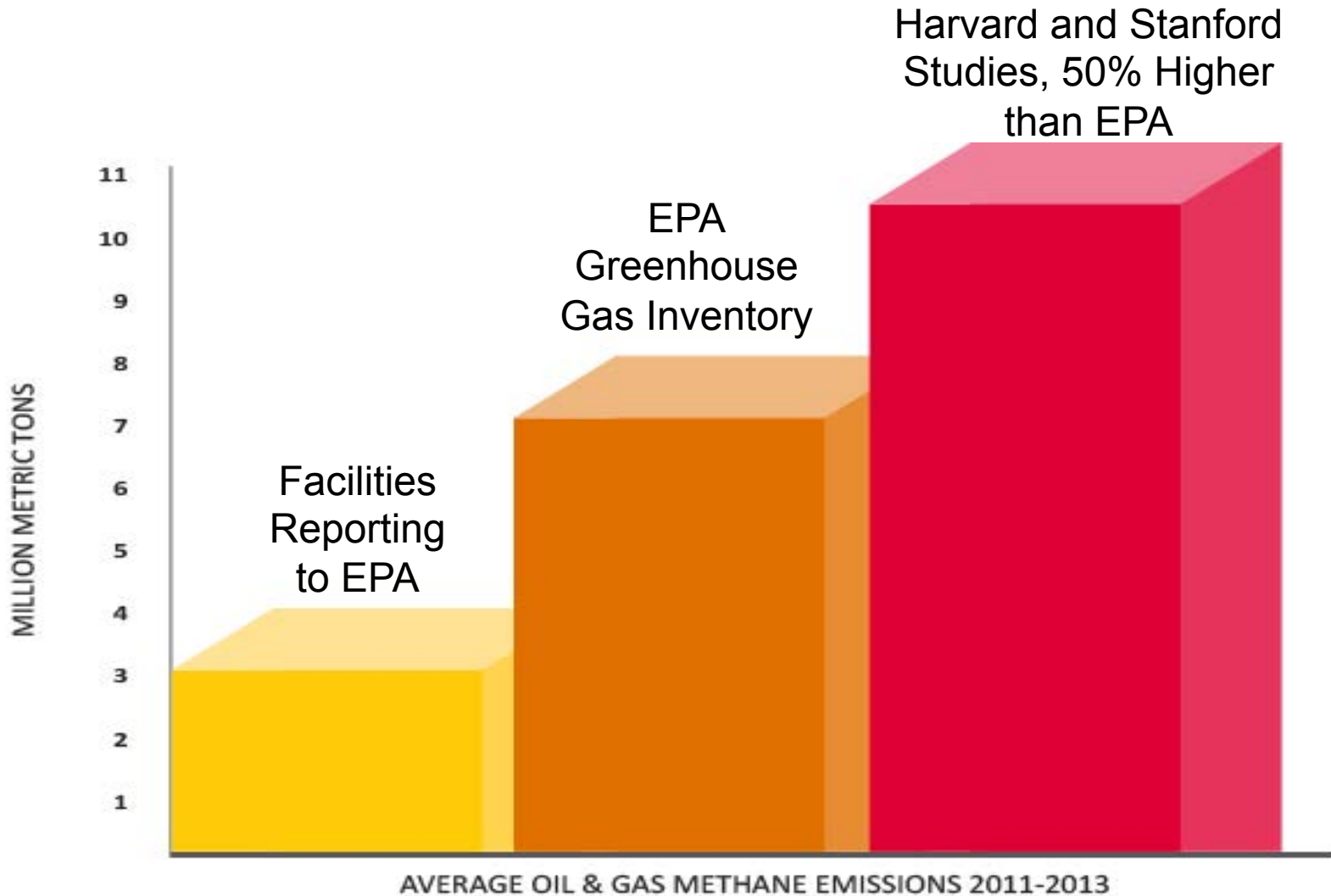


1. **December 2013:** UT Production study: <http://www.pnas.org/lookup/doi/10.1073/pnas.1304880110>
 2. **May 2014:** NOAA DJ Basin Flyover: <http://onlinelibrary.wiley.com/doi/10.1002/2013JD021272/pdf>
 3. **November 2014:** HARC/EPA Fence-line study: <http://pubs.acs.org/doi/abs/10.1021/es503070q>
 4. **December 2014** UT Pneumatics Study: <http://pubs.acs.org/doi/abs/10.1021/es5040156>
 5. **December 2014** UT Liquid Unloadings Study: <http://pubs.acs.org/doi/abs/10.1021/es504016r>
 6. **January 2015:** Harvard Boston Urban Methane Study:
<http://www.pnas.org/content/early/2015/01/21/1416261112>
 7. **February 2015:** CSU Transmission and Storage study: Measurement paper:
<http://pubs.acs.org/doi/abs/10.1021/es5060258>
 8. **February 2015:** CSU Gathering and Processing study: Measurement paper:
<http://pubs.acs.org/doi/abs/10.1021/es5052809>
 9. **March 2015:** WSU Local Distribution study: <http://pubs.acs.org/doi/abs/10.1021/es505116p>
 10. **May 2015:** CSU Gathering and Processing study, Methods paper:
<http://www.atmos-meas-tech.net/8/2017/2015/amt-8-2017-2015.html>
 11. **July 2015:** CSU Transmission and Storage study National results paper:
<http://pubs.acs.org/doi/abs/10.1021/acs.est.5b01669>
 12. **August 2015:** CSU Gathering and Processing study CSU Gathering and Processing study
National results paper: <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b02275>
- Barnett Coordinated Campaign Papers (July 2015)**
13. **Overview:** <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b02305>
 14. **NOAA led Top-down study:** <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00217>
 15. **Bottom-up inventory - EDF:** <http://pubs.acs.org/doi/abs/10.1021/es506359c>
 16. **Functional super-emitter study - EDF:** <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00133>
 17. **Michigan airborne study:** <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00219>
 18. **WVU compressor study:** <http://pubs.acs.org/doi/abs/10.1021/es506163m>
 19. **Princeton near-field study:** <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00705>
 20. **Purdue aircraft study:** <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00410>
 21. **Aerodyne mobile study:** <http://pubs.acs.org/doi/abs/10.1021/es506352j>
 22. **U of Houston mobile study:** <http://pubs.acs.org/doi/abs/10.1021/es5063055>
 23. **Picarro mobile flux study:** <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00099>
 24. **Cincinnati tracer apportionment:** <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00057>

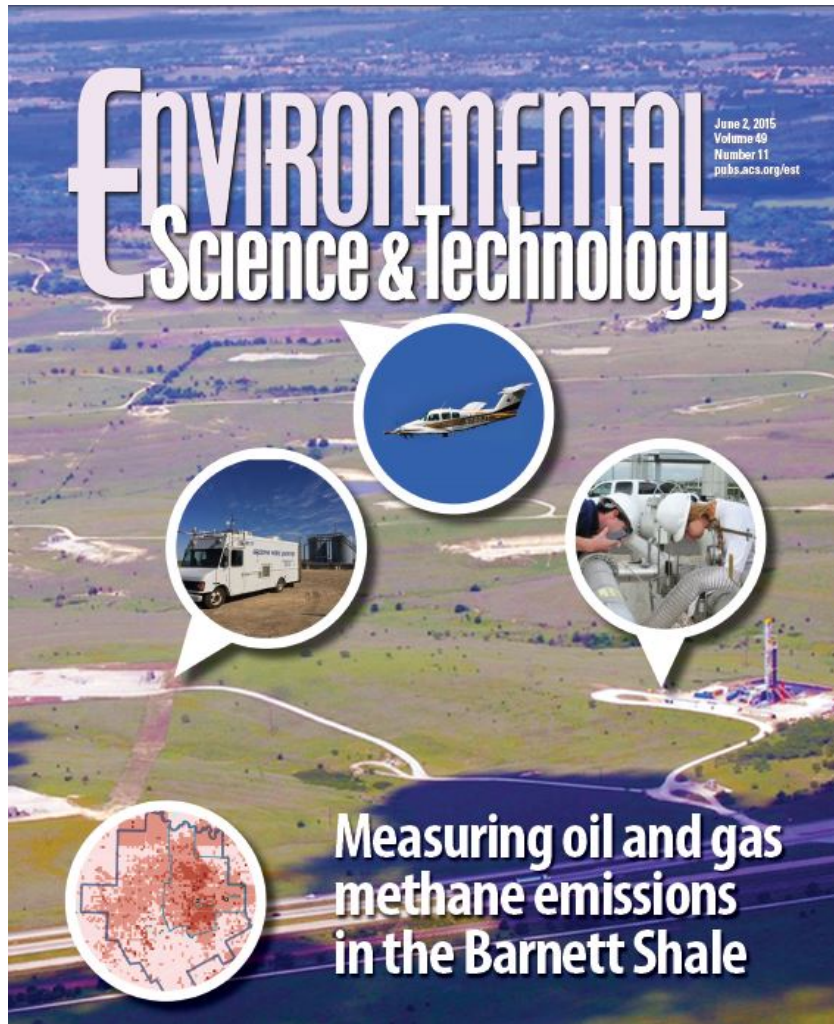
3 Lessons Learned from the Studies

1. Oil and gas methane emissions are higher than conventional estimates suggest;
 2. Reducing emissions is straightforward and cost-effective; and
 3. Regulations work to narrow the range of performance amongst companies.
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1. Emissions Higher than Estimates



Emissions Higher than Estimates

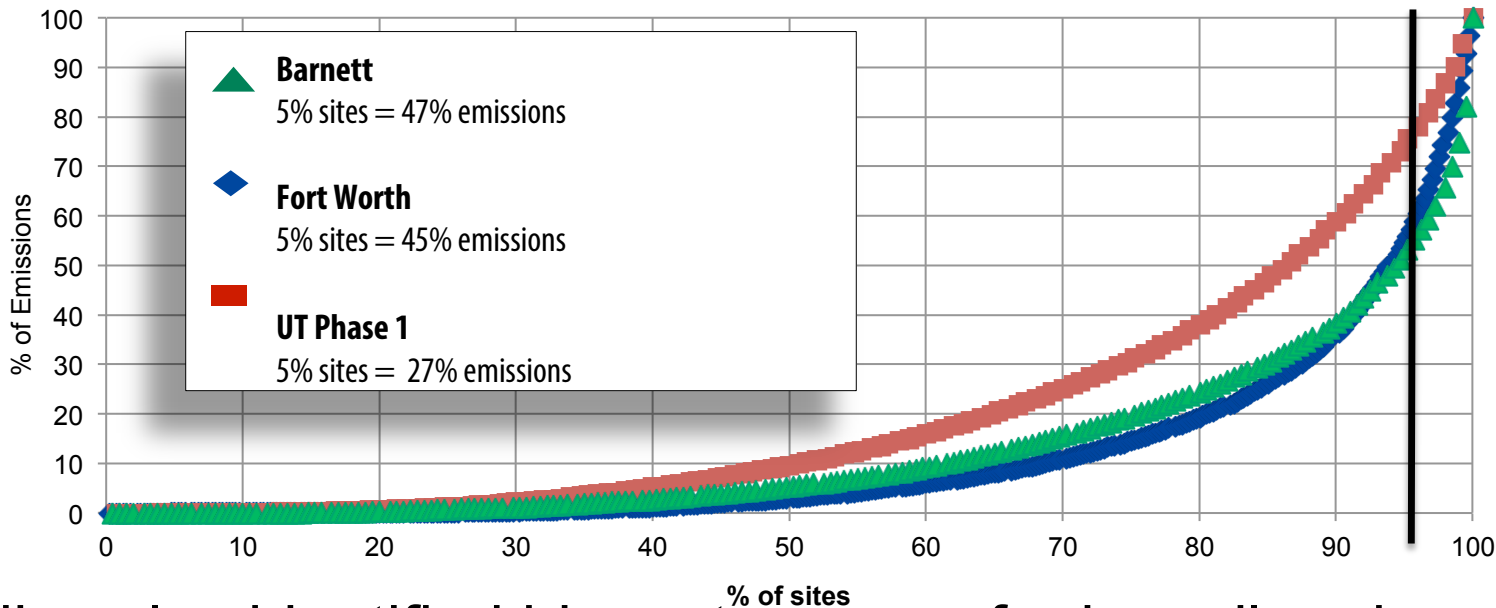


Barnett Coordinated Campaign (July 2015) found:

- Anthropogenic methane emissions were **50% higher** than estimates derived from the EPA inventory, and
- Actual number of facilities may be **five times higher** than reported by other sources.

2. Reducing Emissions is Straightforward...

- Multiple studies found “super-emitters” where a small percentage of sites drive overall emissions:

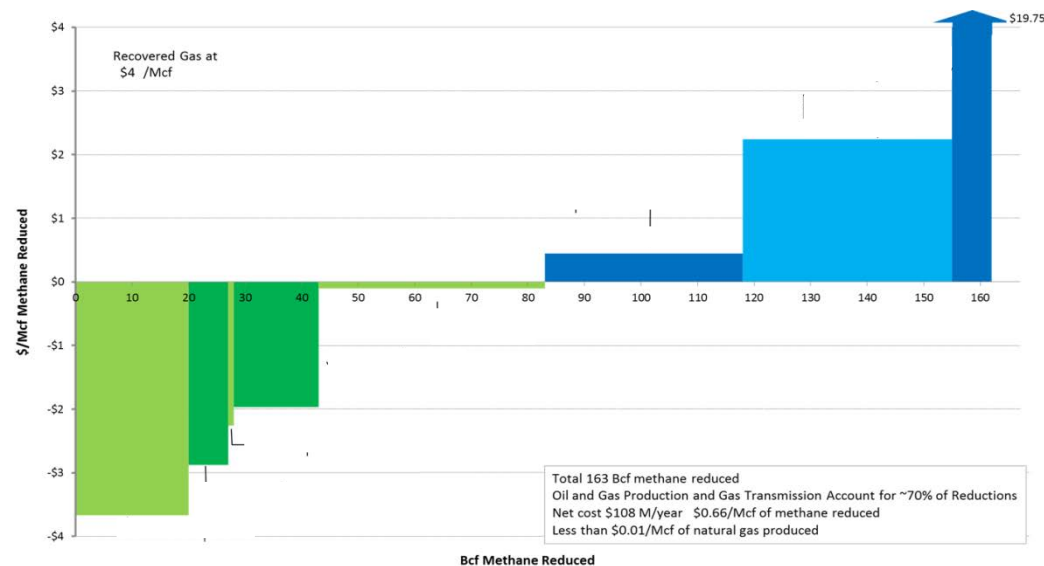


- Studies also identified biggest sources for key oil and gas sectors and we know the technologies to reduce these emissions.

Production Emissions		Transmission & Storage Emissions		Local Distribution Emissions	
Source	Gg 2012 CH4	Source	Gg 2012 CH4	Source	Gg 2012 CH4
Pneumatic Controllers	600	Reciprocating Compressors	366	Pipeline Mains	132
Equipment leaks	307	Equipment leaks	353	Service pipelines	63.6
Liquid Unloadings	270	Uncombusted Methane in Exhaust	117	M&R Facilities	42.3

...Reducing Emissions is Cost-Effective

- ICF Study found U.S. oil and gas methane emissions can be reduced by 40% for less than one cent per million cubic feet of gas, using existing technologies.



- Data shows Wyoming and Colorado methane regulations have led to increased oil and gas jobs and increased production.

3. Regulations Work

- UT study found regulations requiring reduced emission completion technologies **reduced methane by 99%**.
- CSU Transmission and Storage study found a wide range of performance amongst companies, with **participating companies having emissions 30 percent lower than companies that were not involved**. Smart regulations can narrow the gap and ensure best-practices are adopted by all companies, not just industry leaders
- Colorado, Wyoming and EPA regulations provide a template to follow, no need to reinvent the wheel.



Questions?

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