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

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Finding the ways that work

Visualizing Unseen Methane

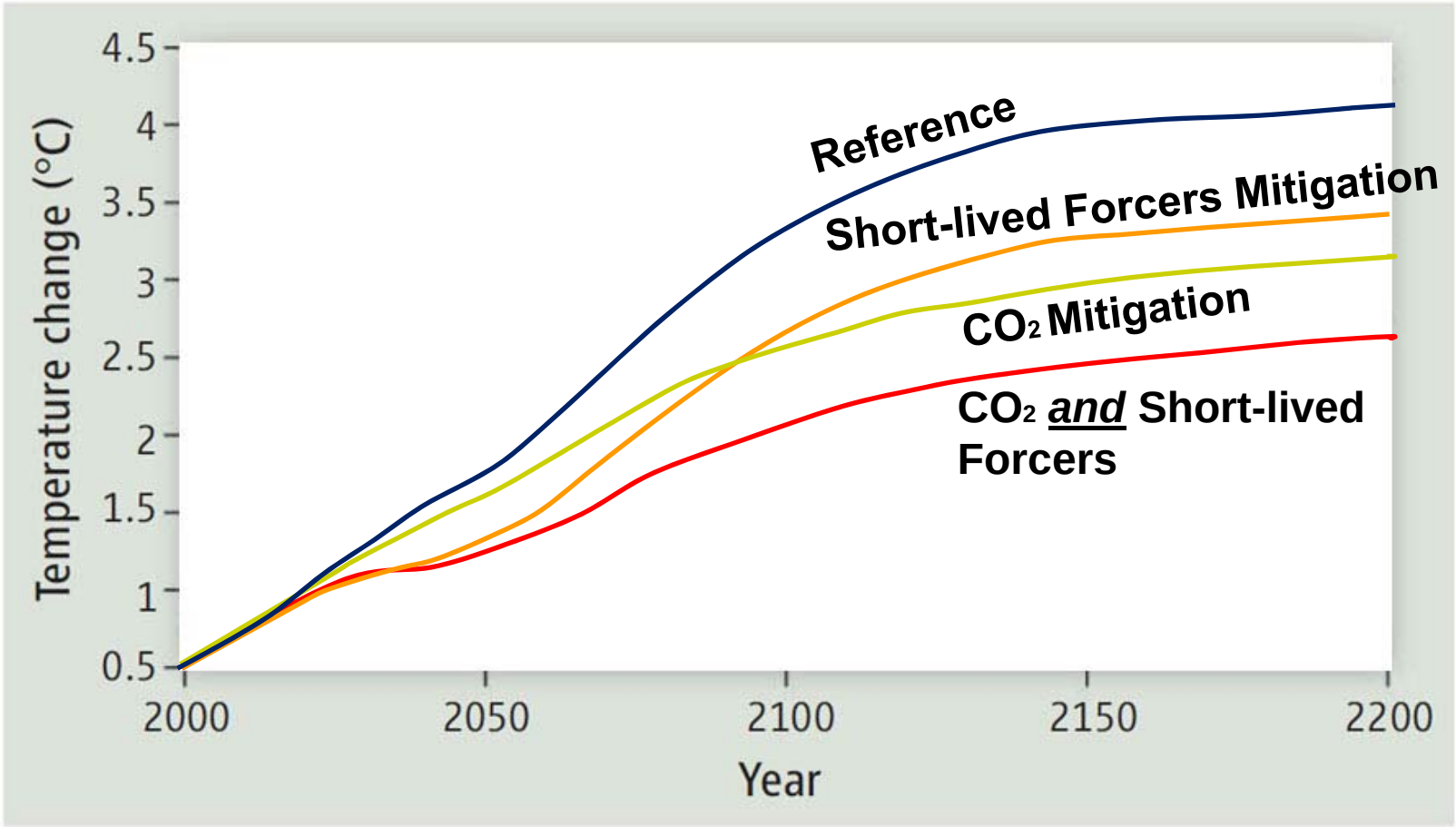
Climate Implications of Methane

POUND FOR POUND METHANE TRAPS
84X MORE HEAT OVER 20 YEARS

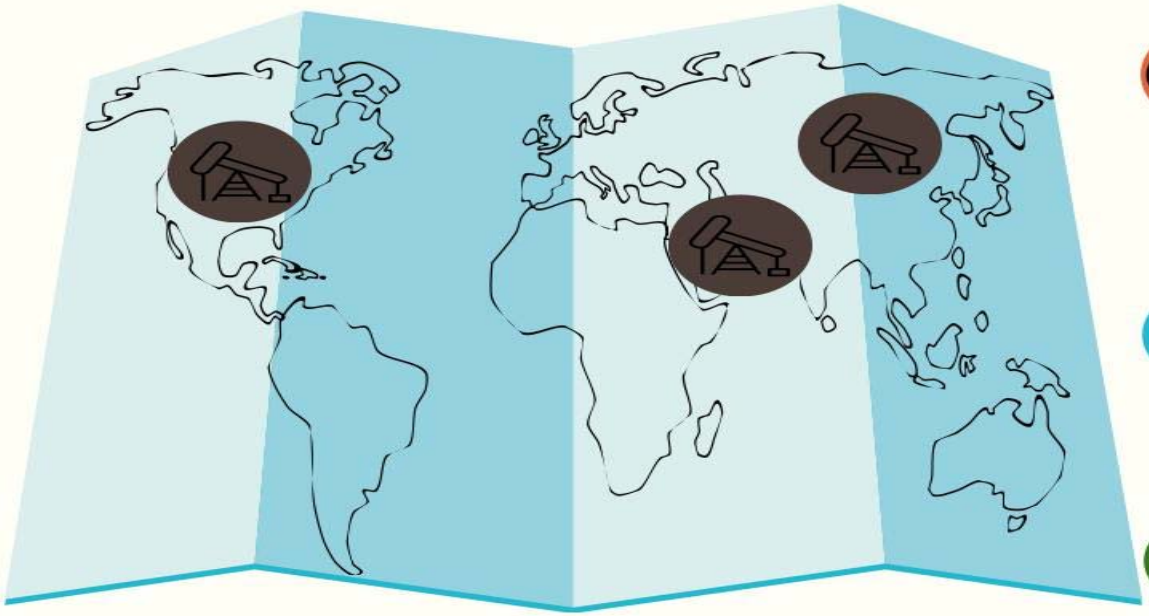
CO_2 CH_4

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

Reduce Methane *and* CO2



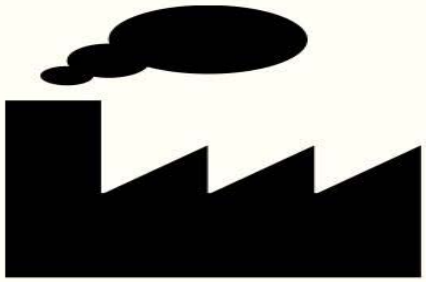
GLOBAL OIL AND GAS METHANE EMISSIONS



Top 30 Countries Account for
75% of Emissions

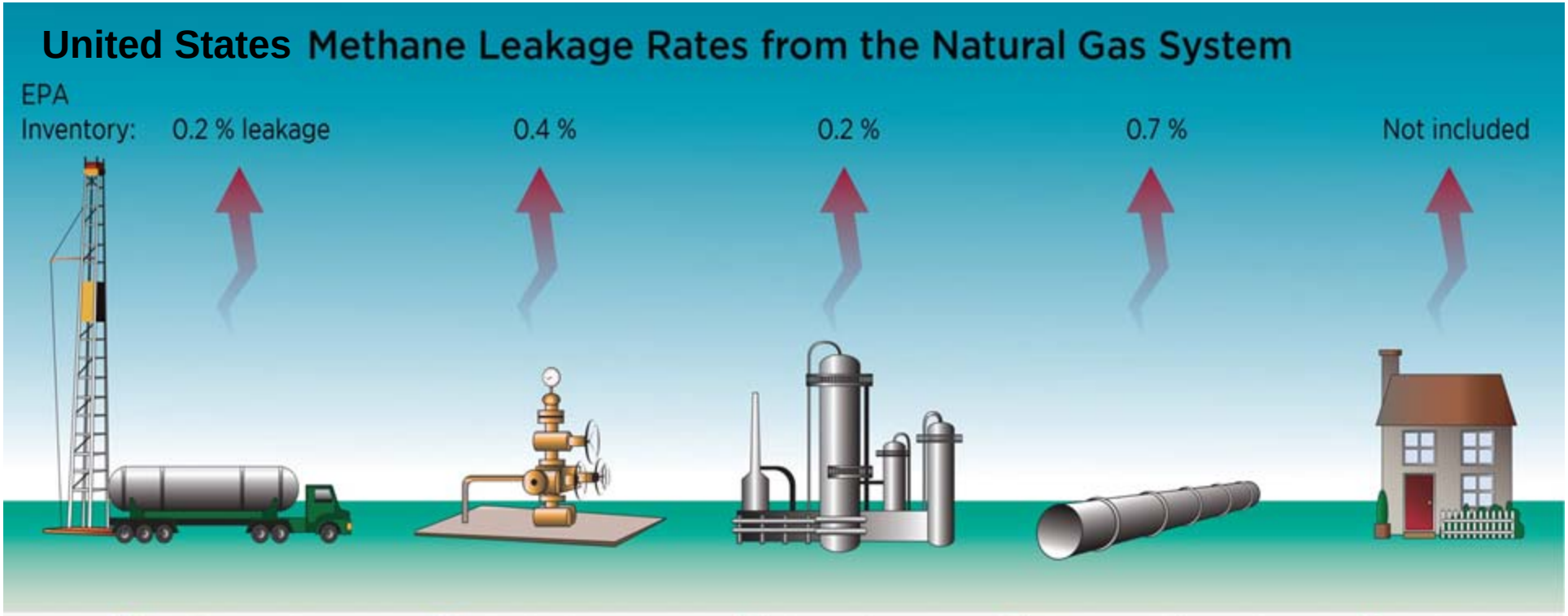
Wasted Gas Equals Norway's Production, 7th Largest Producer

Lost Revenue of
$30 Billion



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

United States Methane Leakage Rates from the Natural Gas System



- Drilling and fracturing
- Production
- Processing
- Transportation and distribution
- End use

EPA estimates current leak rate is 1.3%

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

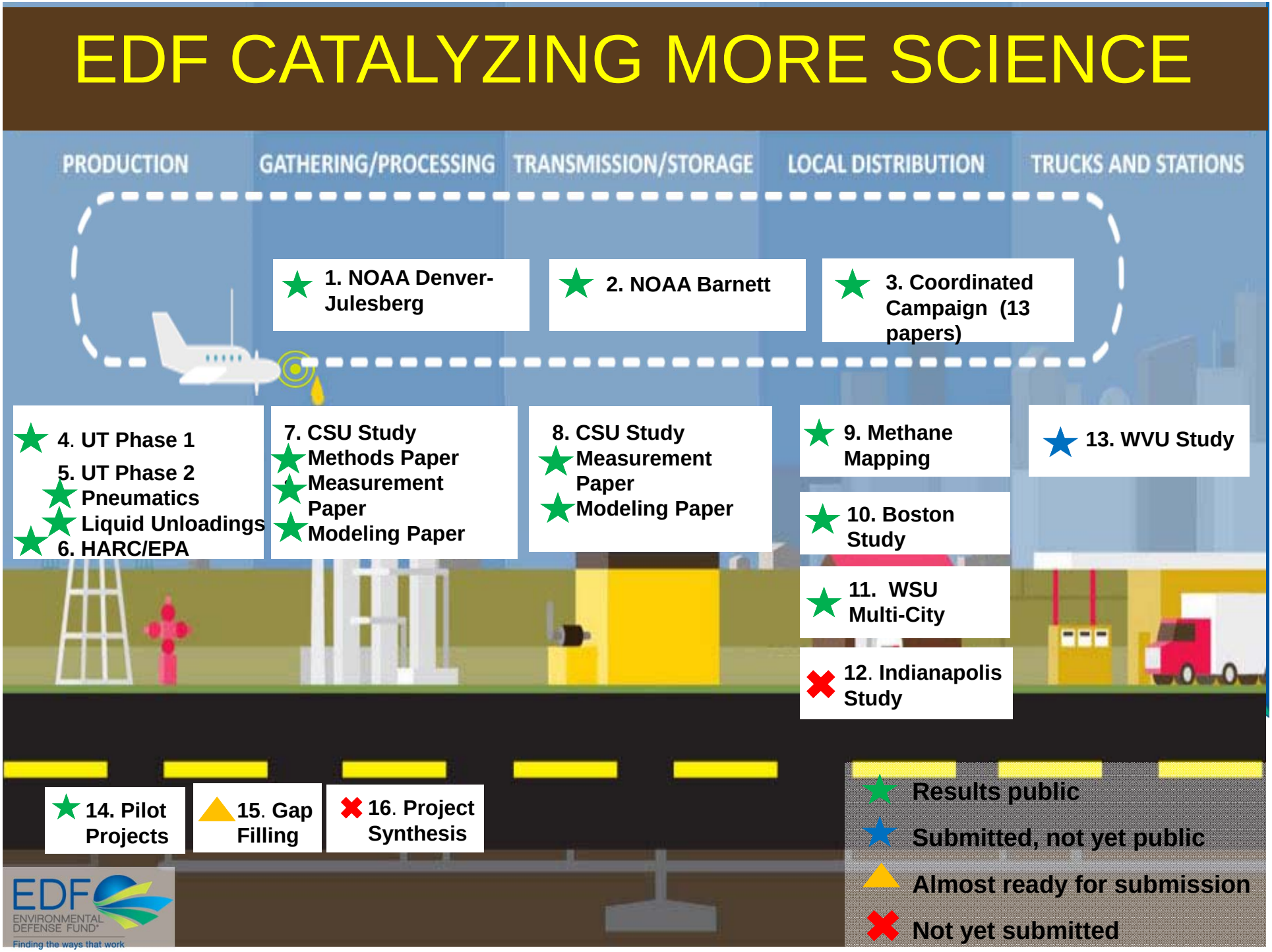
141 Coal-fired Power Plants (35% of US Coal Plants)

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



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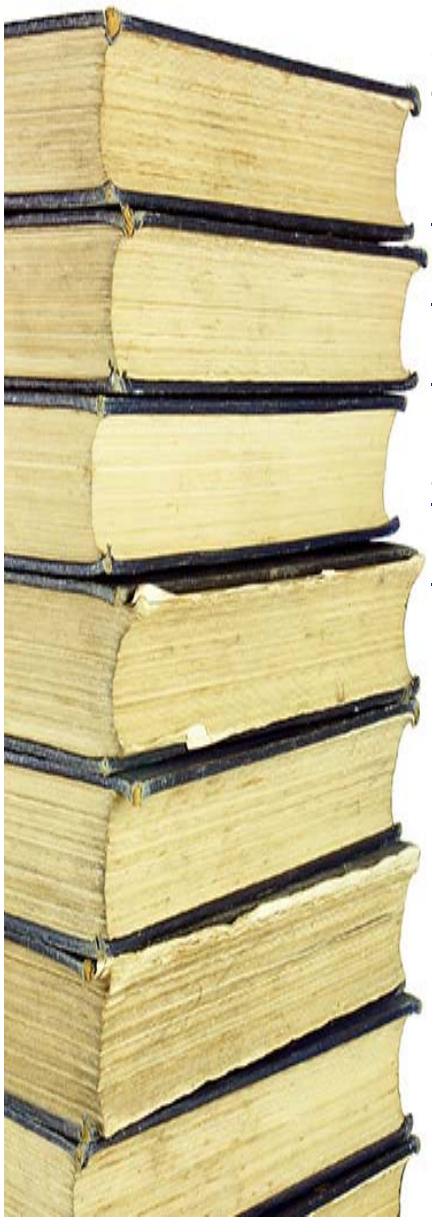
24 Published Studies Thus Far…



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

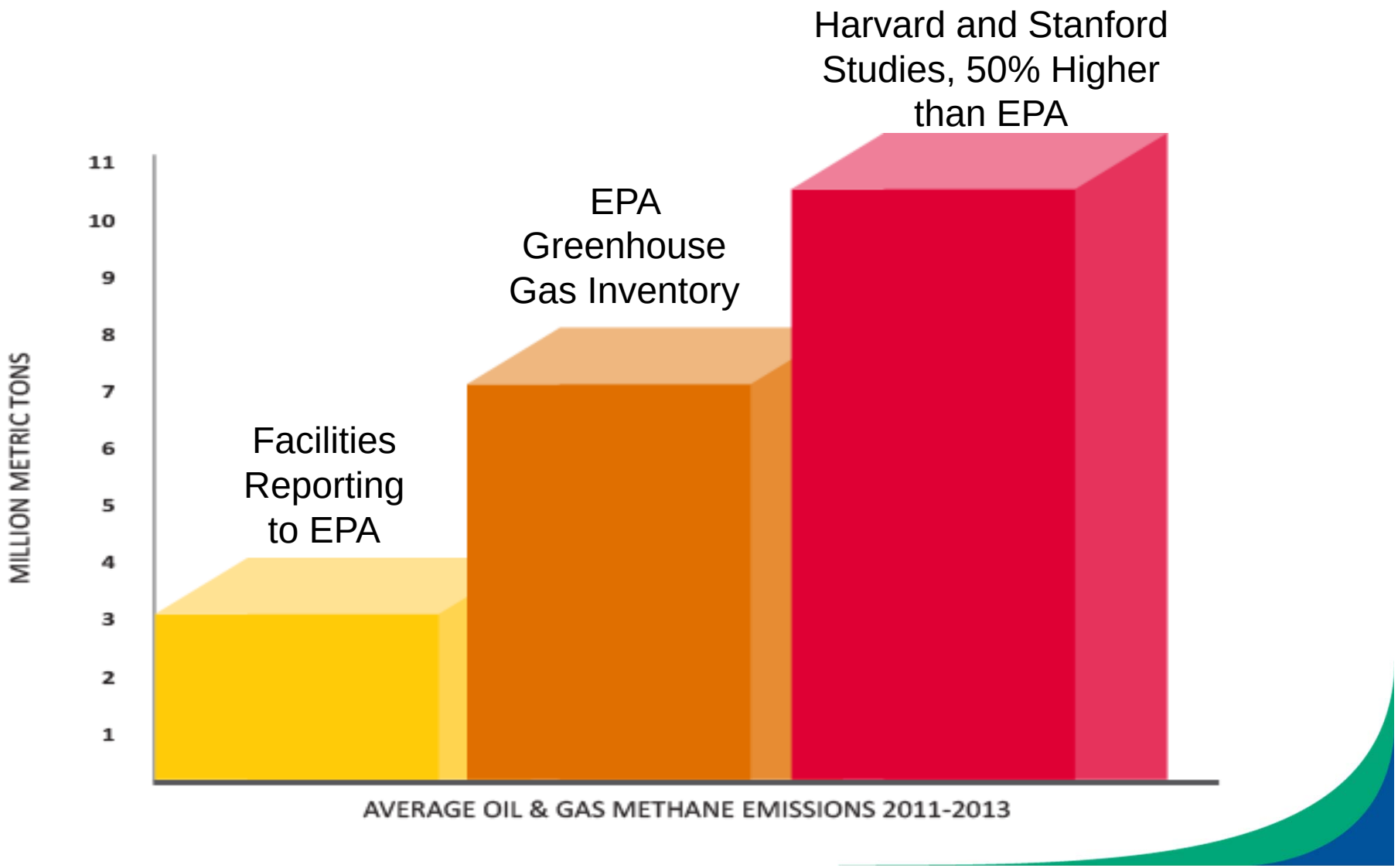
3 Lessons Learned from the Studies

1. Oil and gas methane **emissions are higher** than conventional estimates suggest;

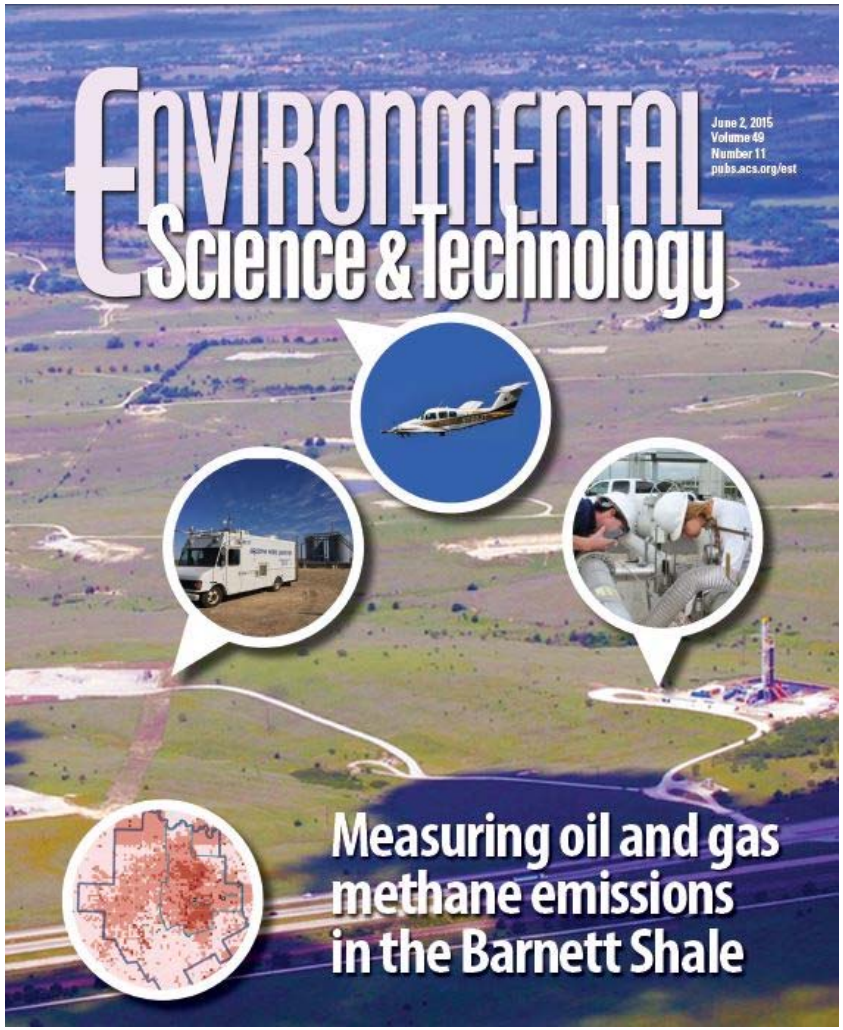
2. Reducing emissions is **straightforward** and **cost-effective;** and

3. **Regulations work** to narrow the range of performance amongst companies.

1. Emissions Higher than Estimates



Emissions Higher than Estimates



Barnett Coordinated Campaign (July 2015) found:

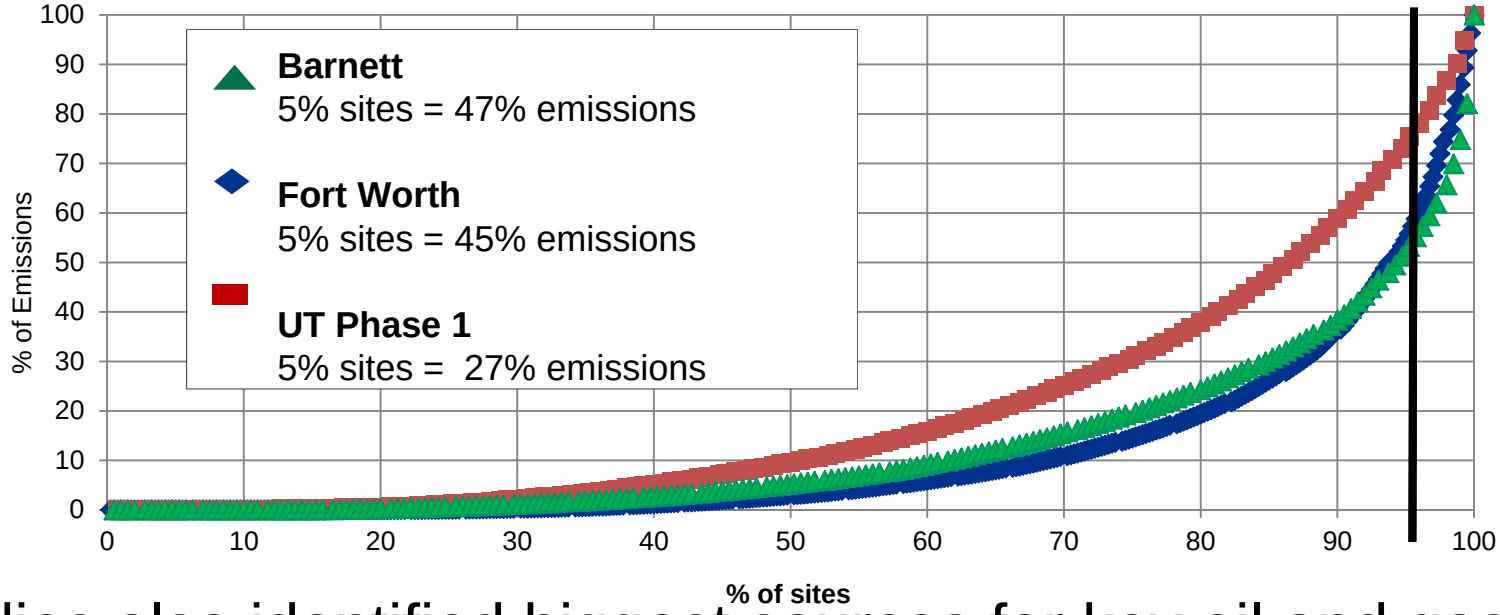
- Anthropogenic methane emissions were **50% higher** than estimates derived from the EPA inventory,

  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:

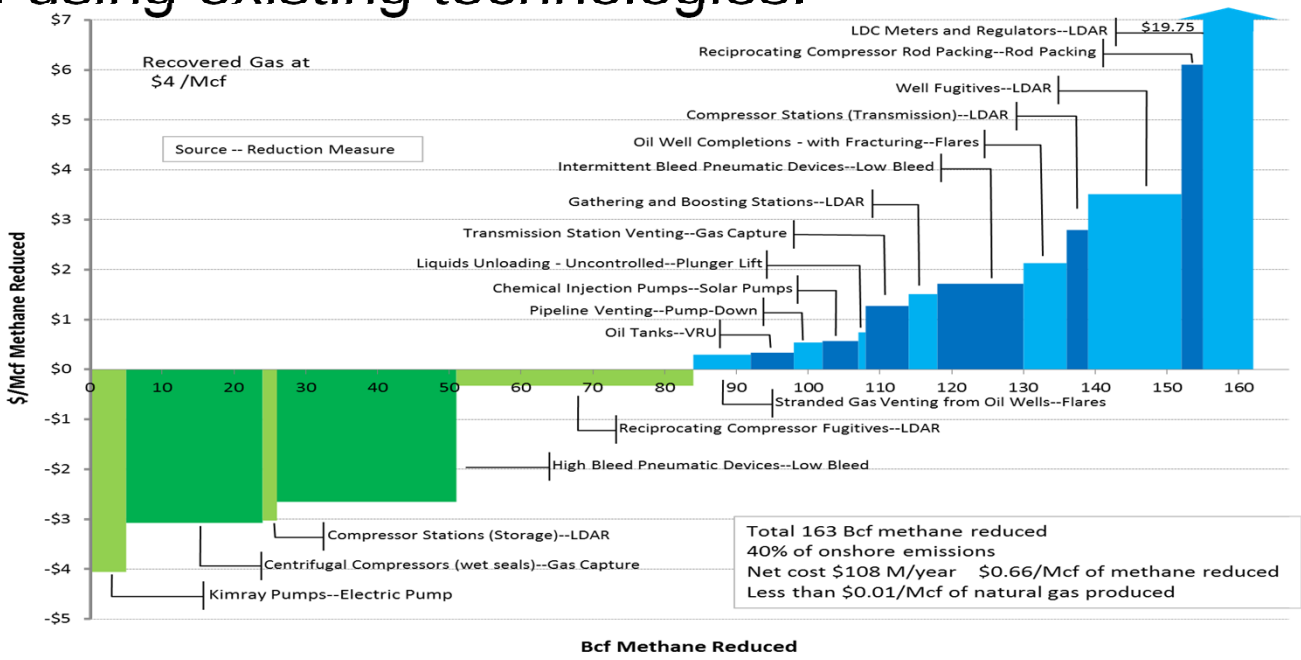


- Studies also identified biggest sources for key oil and gas sectors and we know the technologies to reduce these emissions.

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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