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

Roland Kupers

Mitigating methane emissions:
From science to innovative solutions
November 9, 2015

EDF
ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

Visualizing Unseen Methane

Climate Implications of Methane

KG FOR KG METHANE TRAPS

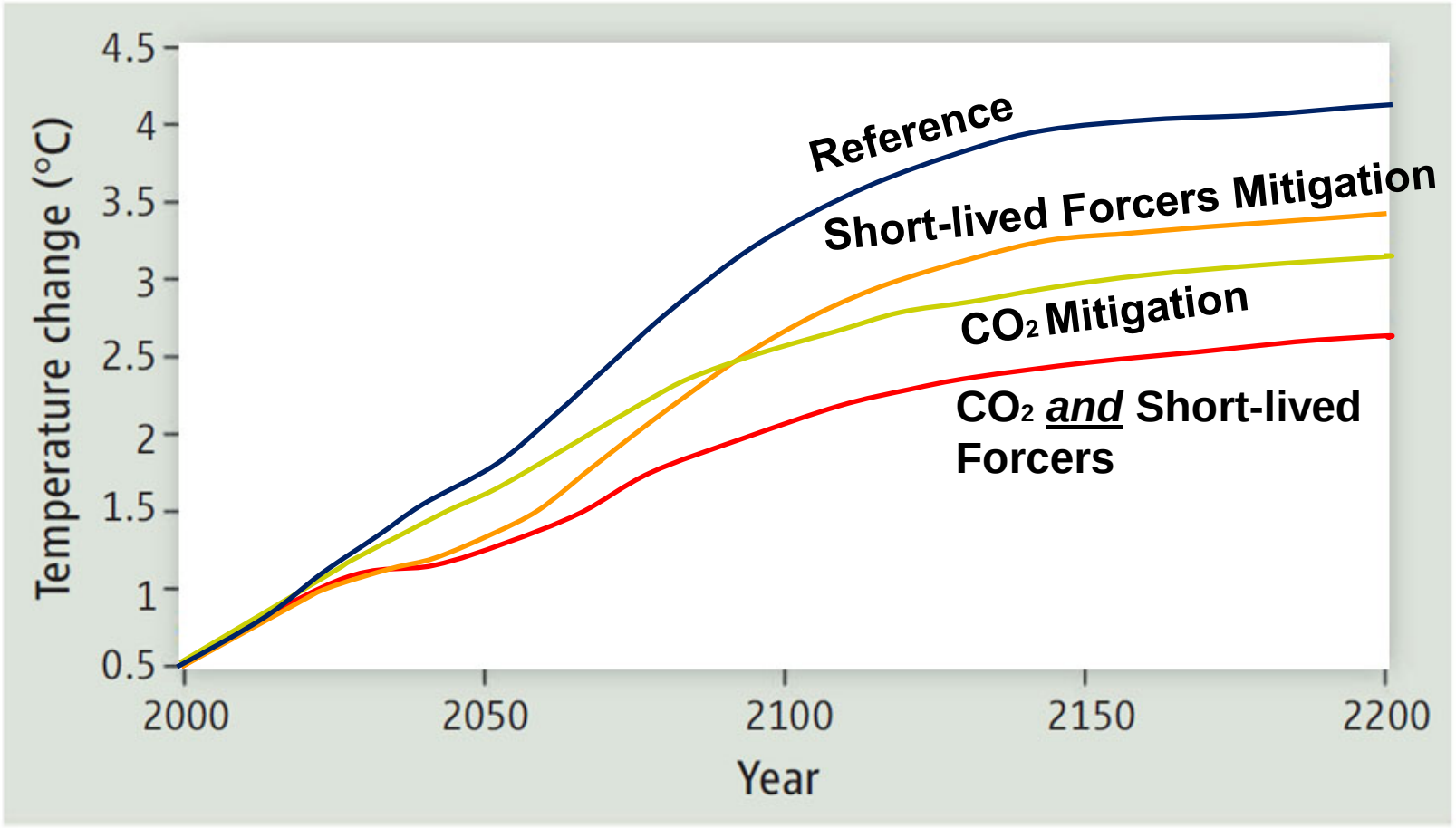
84X MORE HEAT OVER 20 YEARS

CO_2

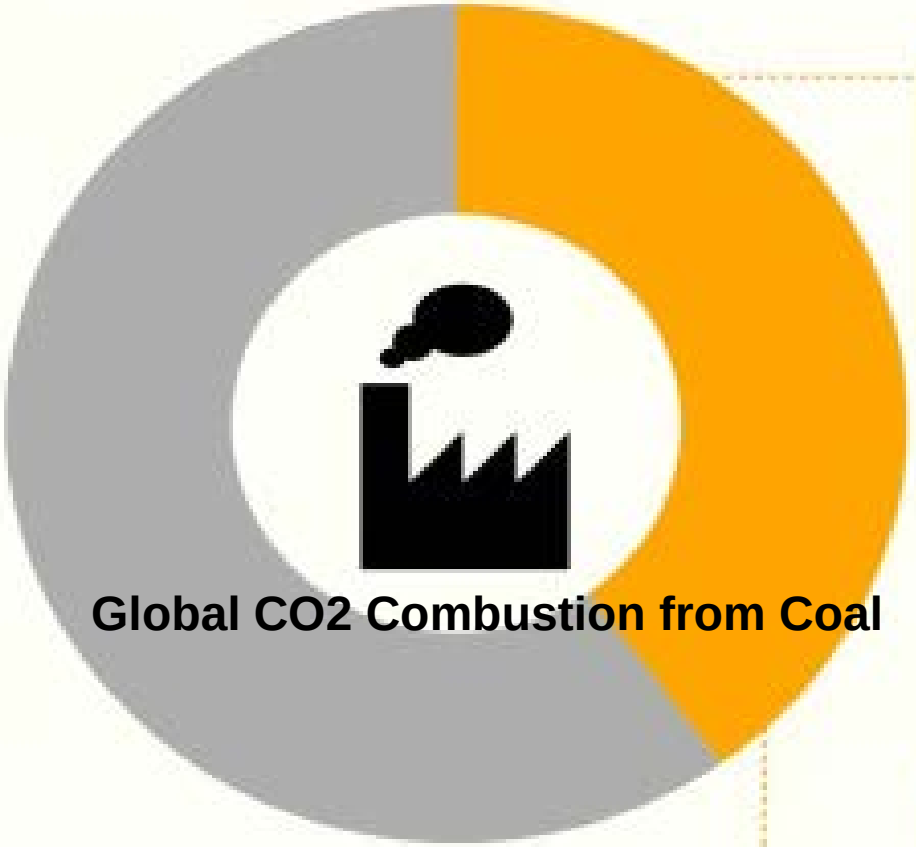
CH_4

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

Reduce Methane *and* CO2



IMPACT OF EMISSIONS



Oil and Gas methane equivalent **to 40% of total CO2 from global coal combustion**

- Approximately 3.5 TCF of gas leaked in 2012.
- Equivalent to Norway's gas production (ranked 7th).
- Translates into $30 Billion of lost revenue, literally vanishing in to thin air.

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

Are national emissions really that different?

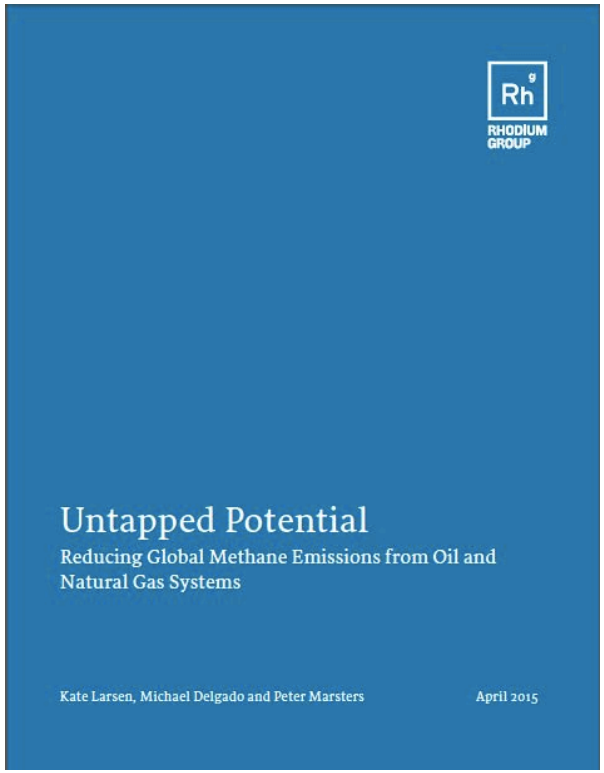
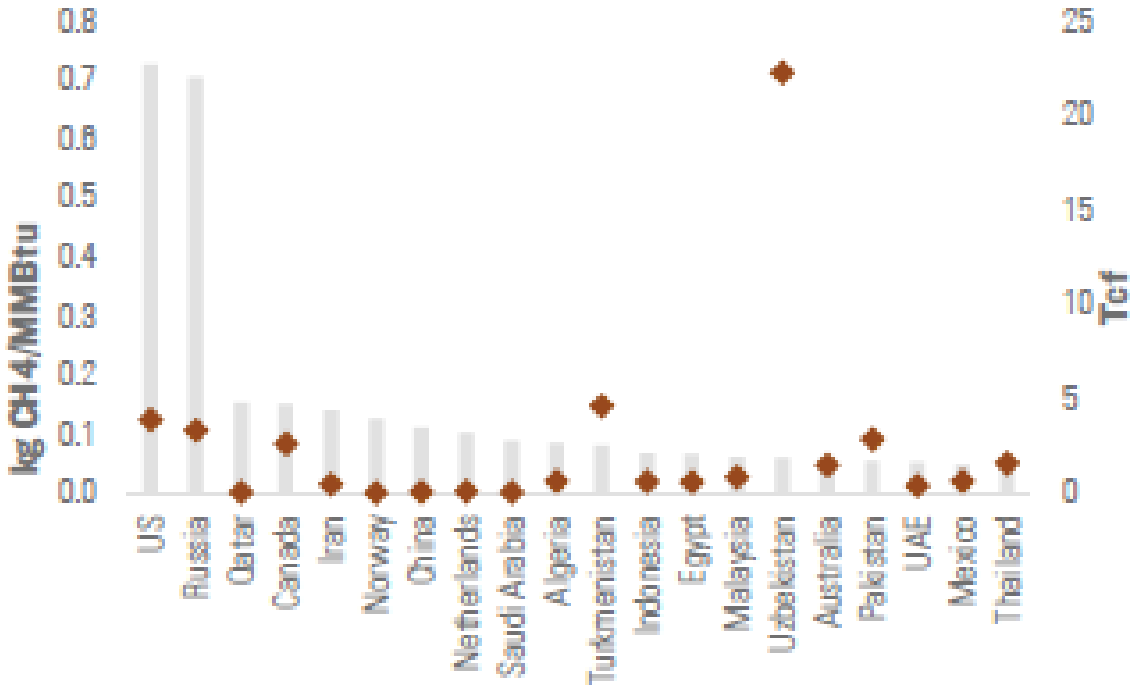


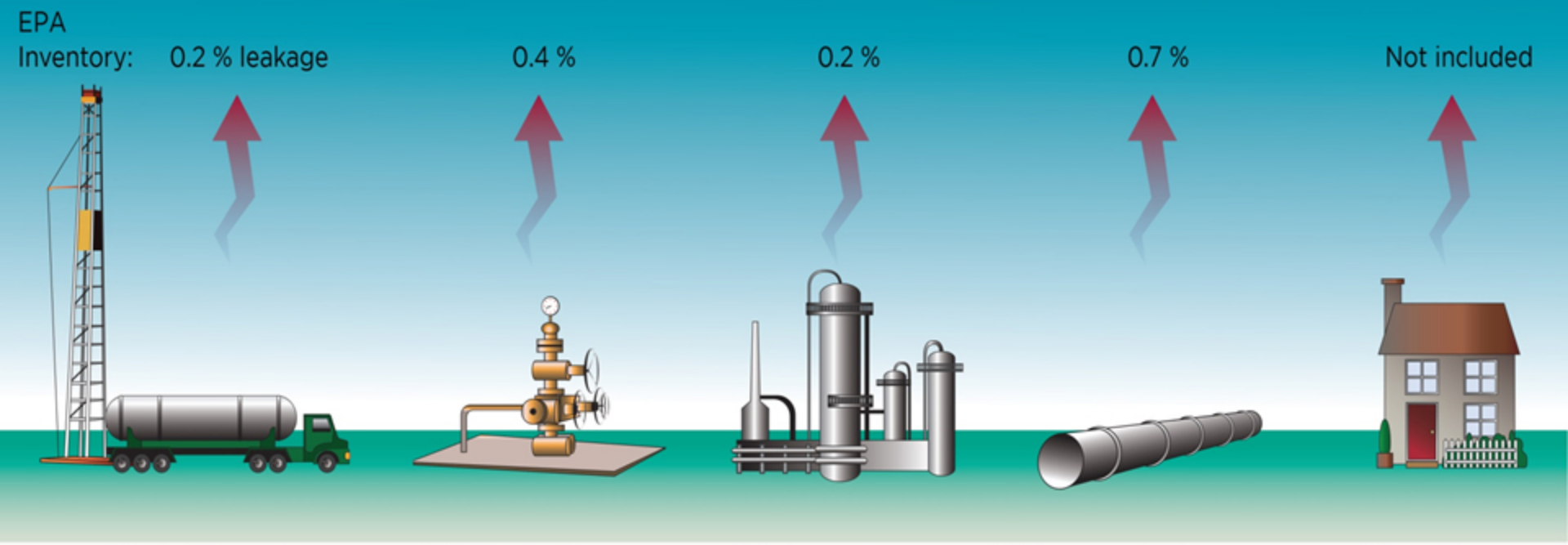
Figure I: Upstream gas methane leakage rates

Leakage rate (left axis, dots) and production (right axis, bars)



Source: UNFCCC, EIA, Rystad and RHG estimates.

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

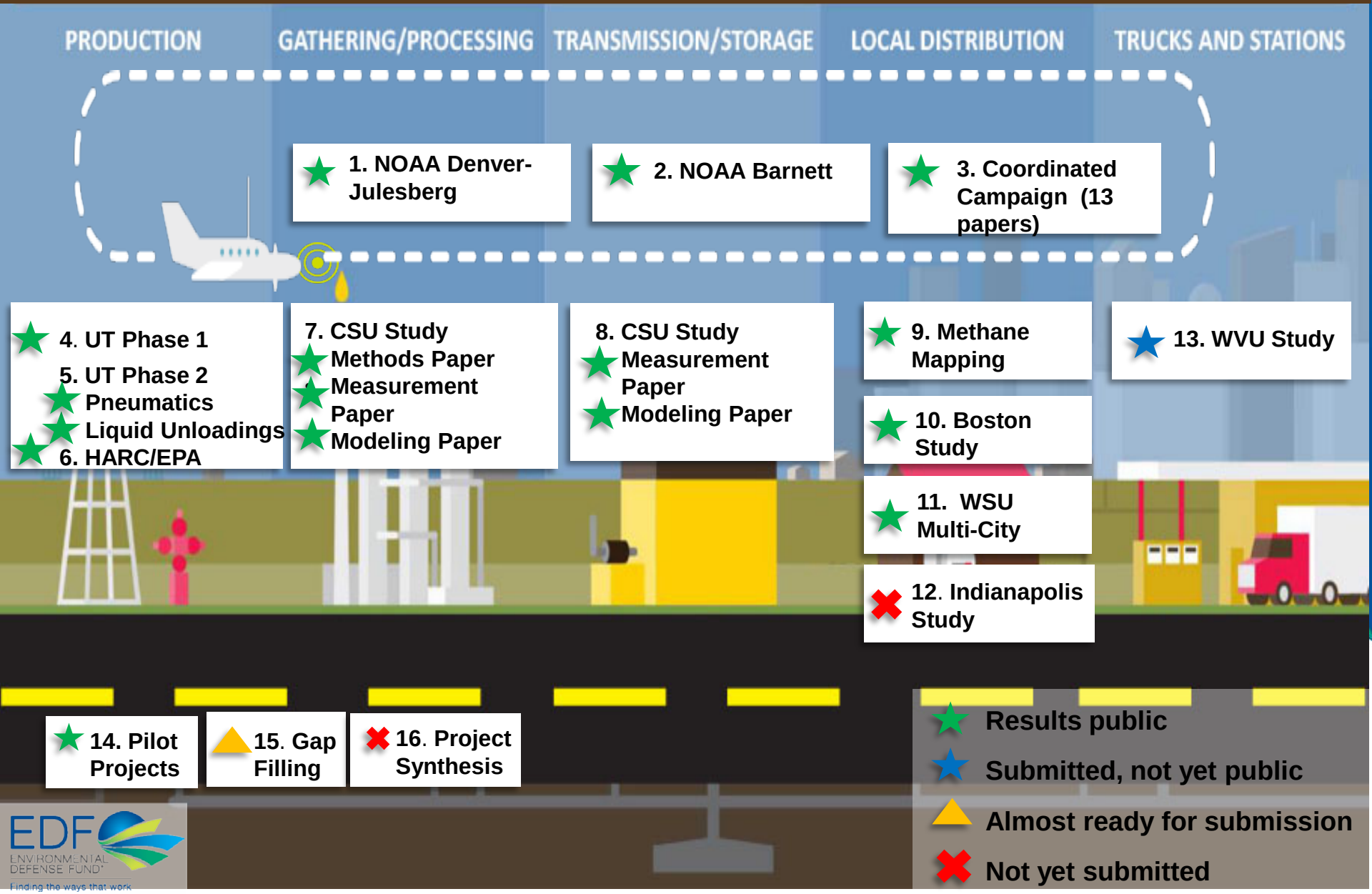
141 Coal-fired Power Plants (35% of US Coal Plants)

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



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Finding the ways that work


Google maps
Street View
google.com/streetview

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

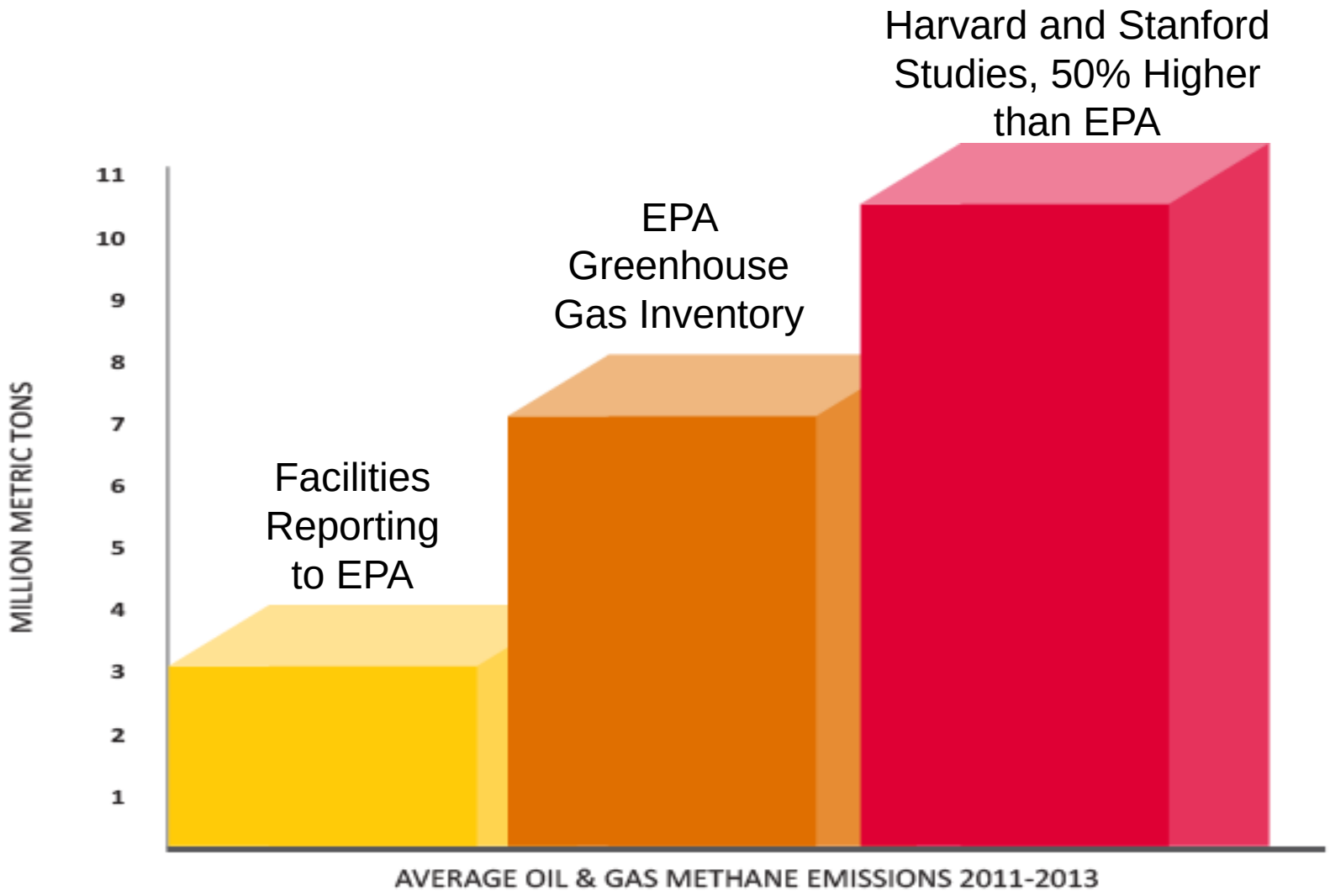
Barnett Coordinated Campaign Papers (July 2015)

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

Lessons Learned from the Studies

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

1. Emissions Higher than Estimates



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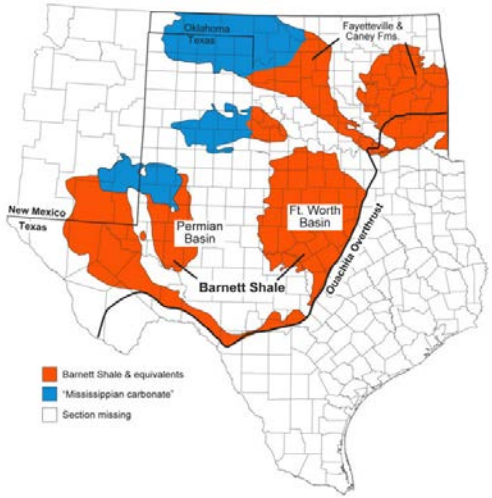
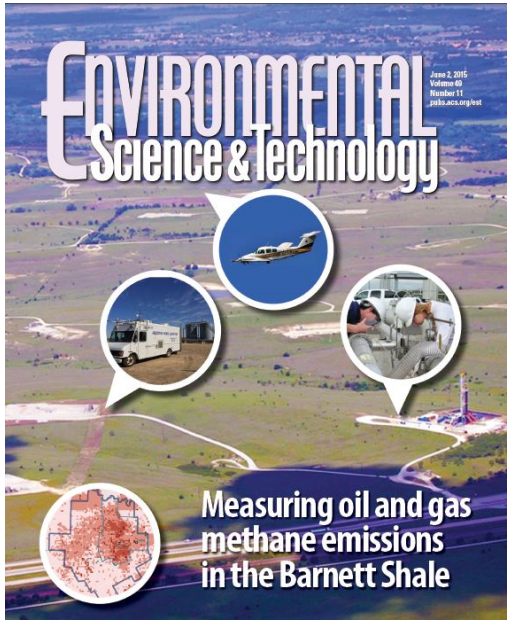
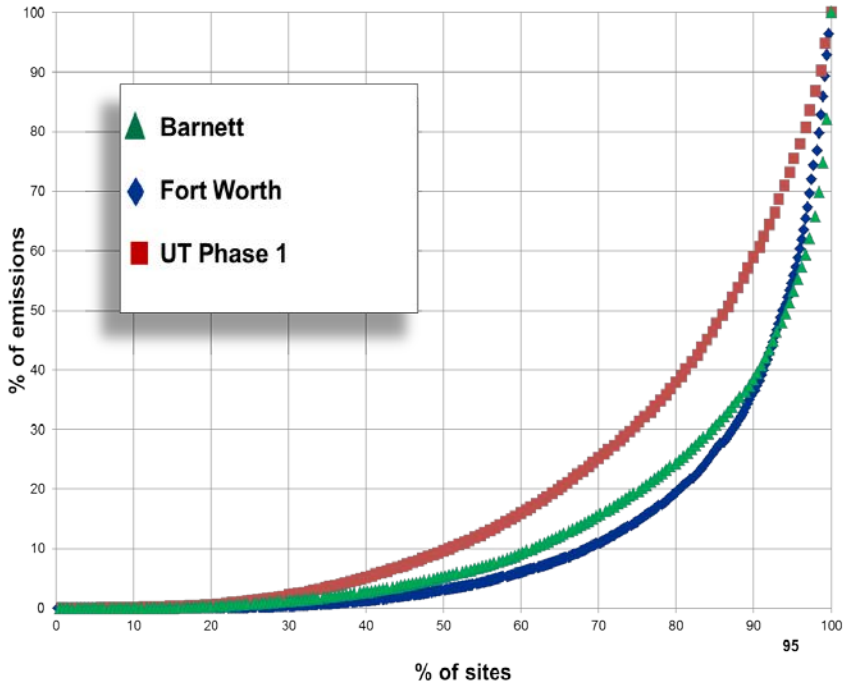




- Comprehensive Barnett study
- Higher emissions
- Underestimate equipment count

2. Reducing Emissions is Straightforward…



- Heavy tailed distribution
- Barnett: 15% emit 75%
- Explains underestimate

A small number of “super-emitters”

2. Reducing Emissions is Straightforward…

Production Emissions

	Source	Gg 2012 CH4
1.	Pneumatic Controllers	600
2.	Equipment leaks	307
3.	Liquid Unloadings	270

Transmission & Storage Emissions

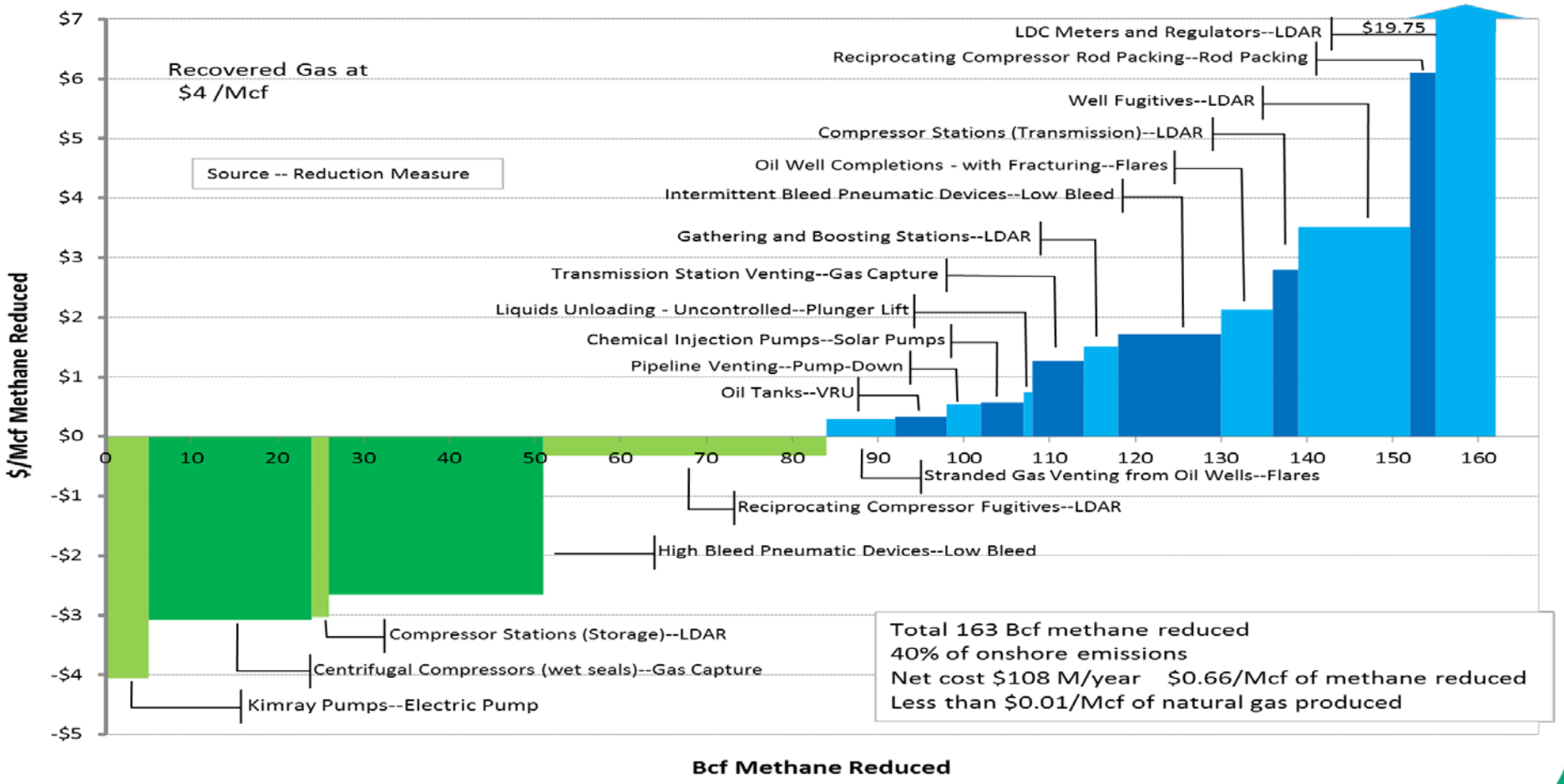
	Source	Gg 2012 CH4
1.	Reciprocating Compressors	366
2.	Equipment leaks	353
3.	Uncombusted Methane in Exhaust	117

Local Distribution Emissions

	Source	Gg 2012 CH4
1.	Pipeline Mains	132
2.	Service pipelines	63.6
3.	M&R Facilities	42.3

Largest U.S. oil and gas emission sources by measured sector

…Reducing Emissions Cost-Effective



US Regulation works

- Clear successes in US
- Substantial reductions
- Fit for purpose

CLIMATE AND CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

CCAC Oil & Gas Methane Partnership

October 2014

An accessible solution

- An underestimated problem
- Known solutions
- Cost effective
- Well-capitalised actors