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

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EDF
ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

Visualizing Unseen Methane

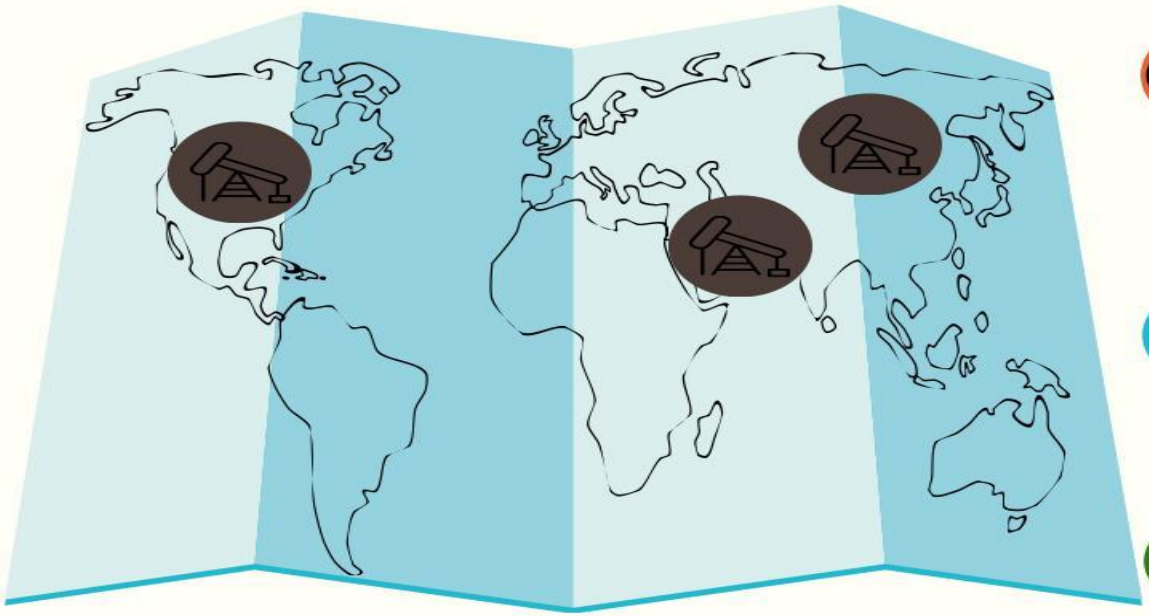
Climate Implications of Methane

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.

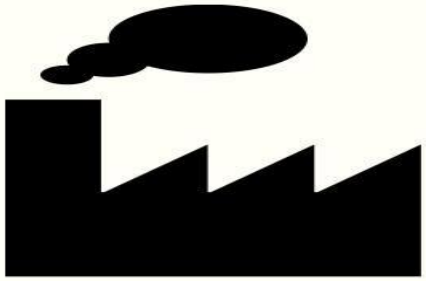
GLOBAL OIL AND GAS METHANE EMISSIONS



Top 30 Countries Account for
75% of Emissions

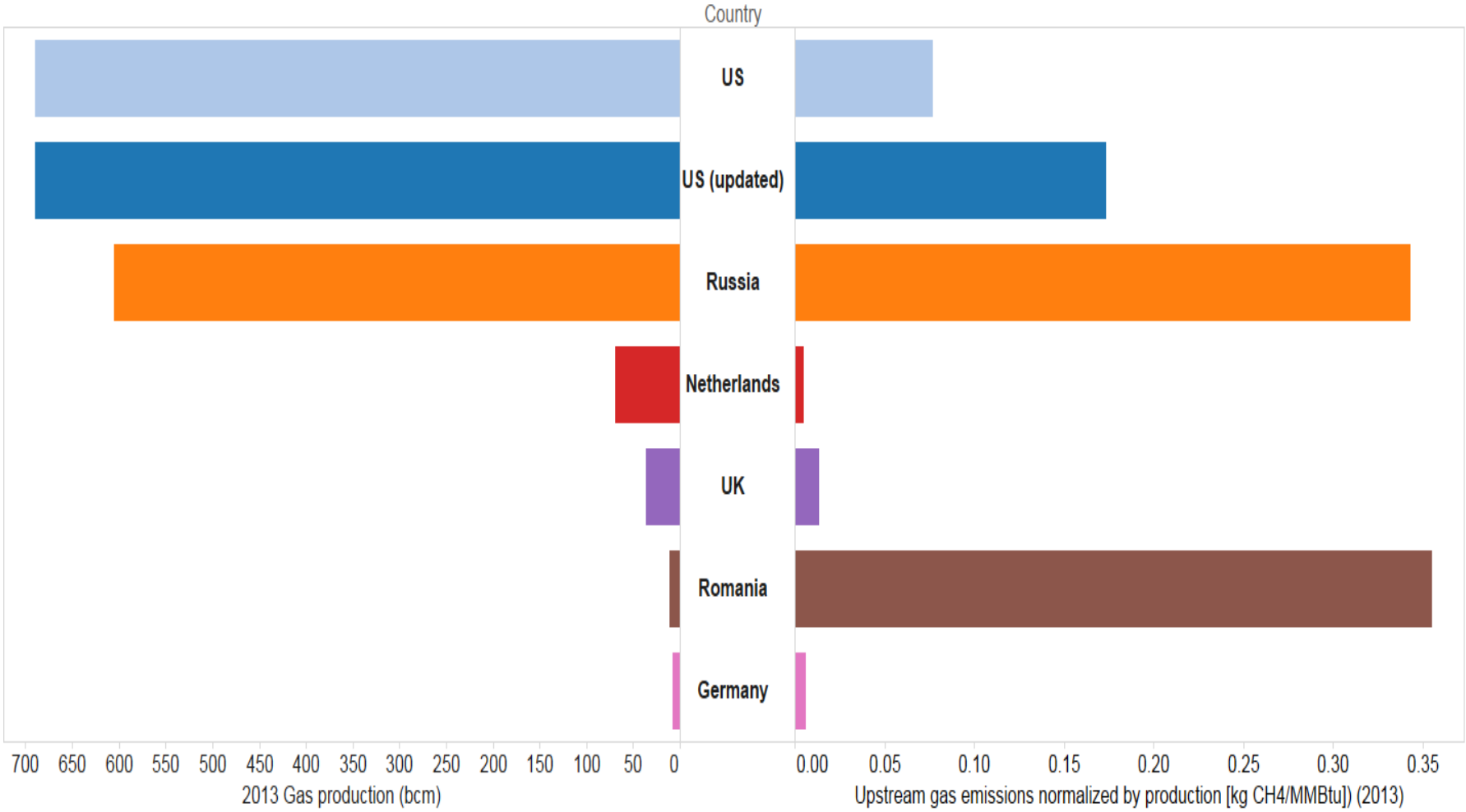
Wasted Gas Equals Norway's Production, 7th Largest Producer

Lost Revenue of
$30 Billion



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

Production vs. Inventory Emissions



EPA Estimates 1.7% Leakage

Equal to GHG emissions of 164 million cars (65% of US Cars)

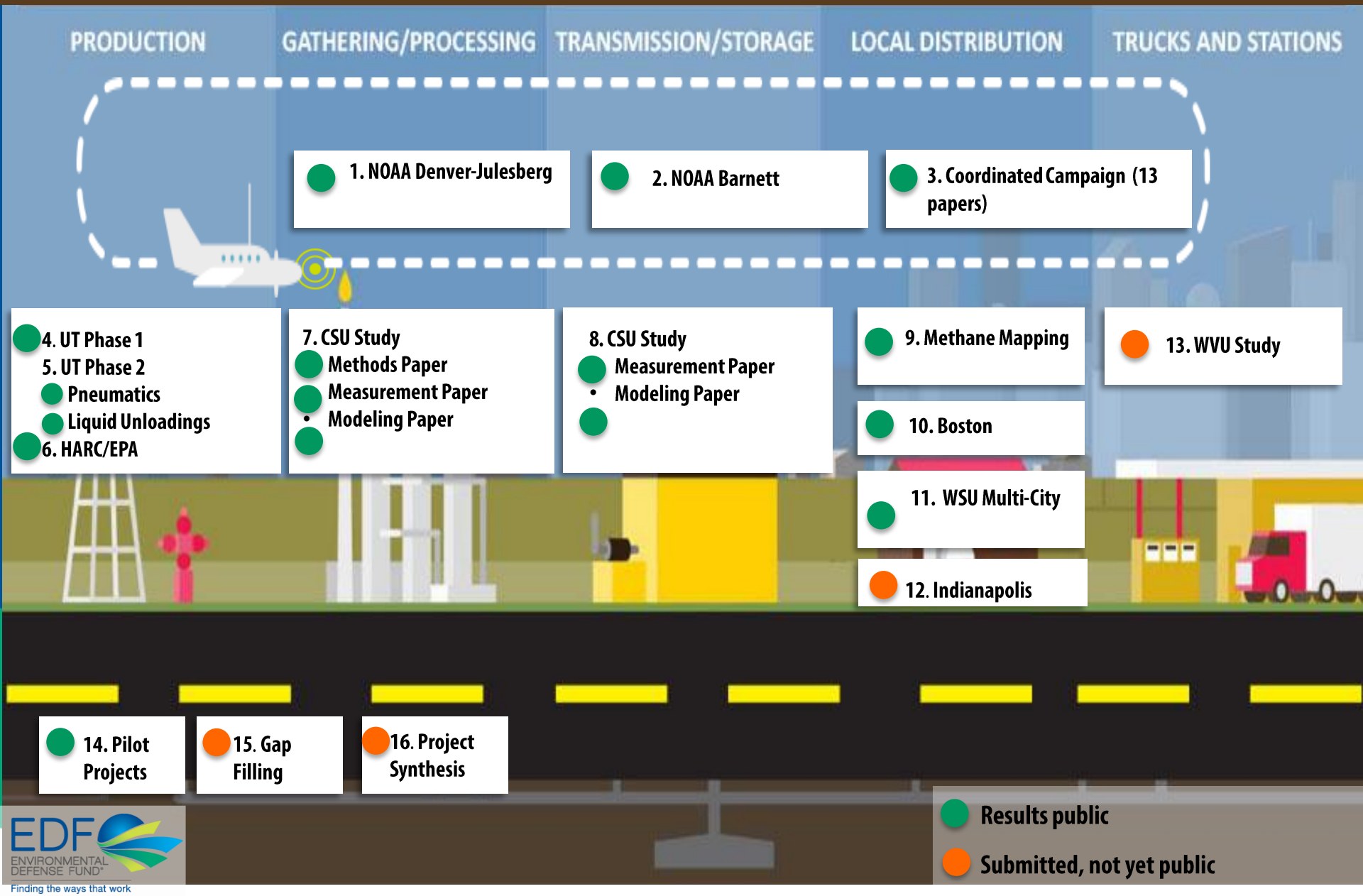
OR

205 Coal-fired Power Plants (Almost 40% of US Coal Plants)

$1.7 to $6.2 billion in lost revenue

Using 20 year GWP of 86

EDF CATALYZING MORE SCIENCE



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26 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) papers 13-24

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
25. **December 2015:** Barnett Synthesis: http://www.pnas.org/content/112/51/15597.abstract
26. **March 2016:** Abandoned & Orphaned Wells: http://onlinelibrary.wiley.com/doi/10.1002/2015GL067623/full

Lessons learned from the studies

1

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

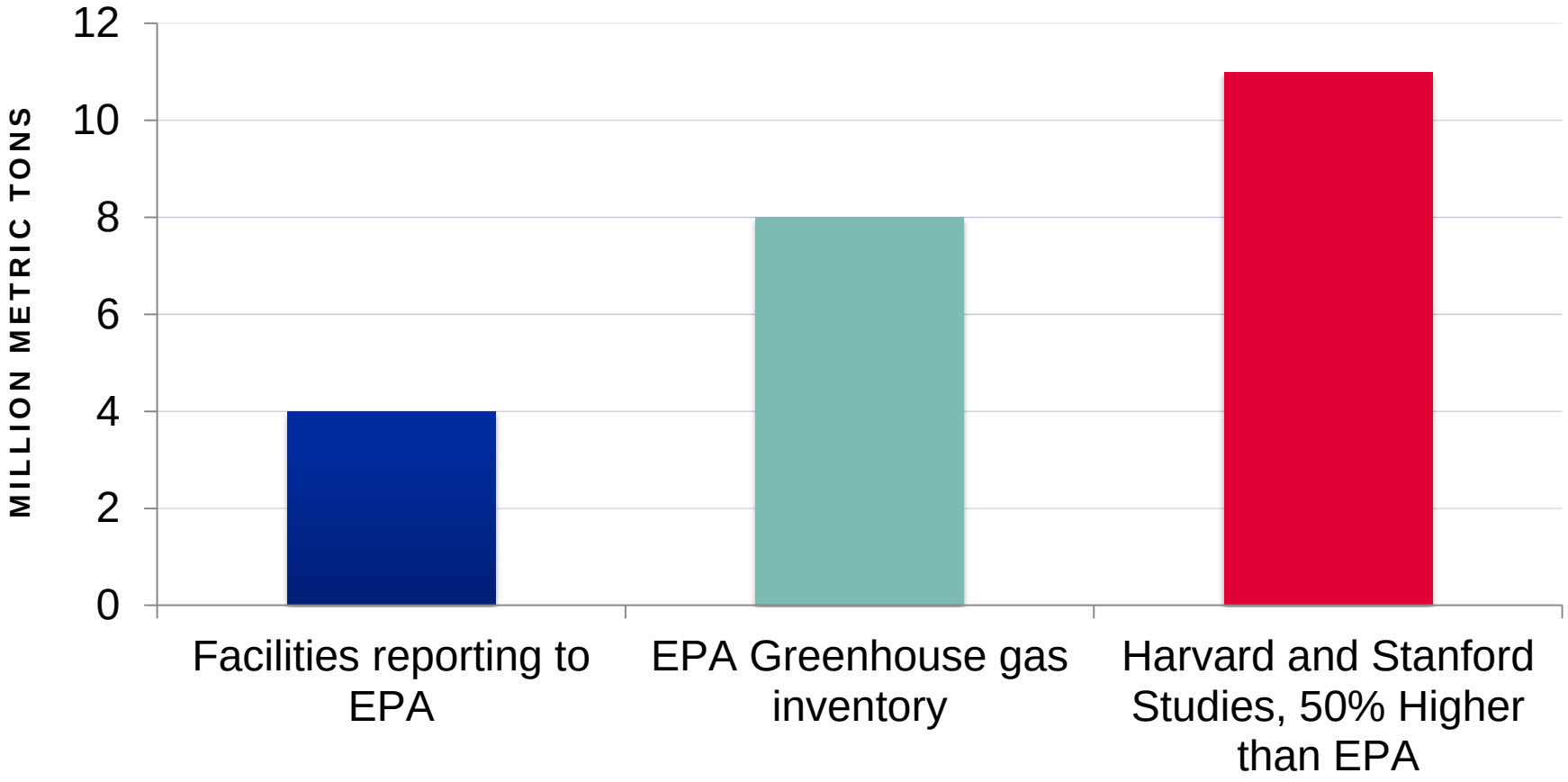
2

Reducing emissions is **straightforward** and **cost-effective**

3

Regulations work to narrow the range of performance amongst companies.

1. Emissions higher than estimates

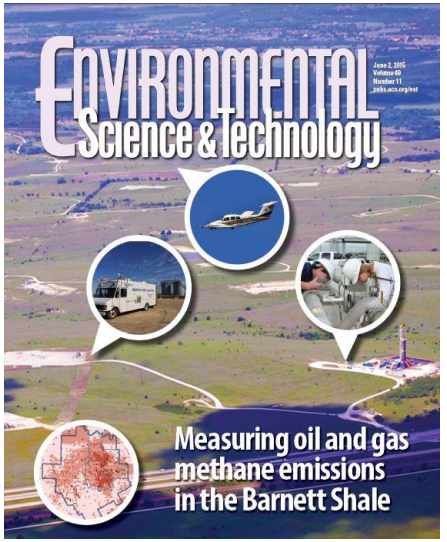


Average Oil and Gas Methane Emissions 2011-2013

1. Emissions higher than estimates

Barnett Coordinated Campaign (July 2015) found:

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



2. Reducing emissions is straightforward

Studies also identified biggest sources for key oil and gas sectors.

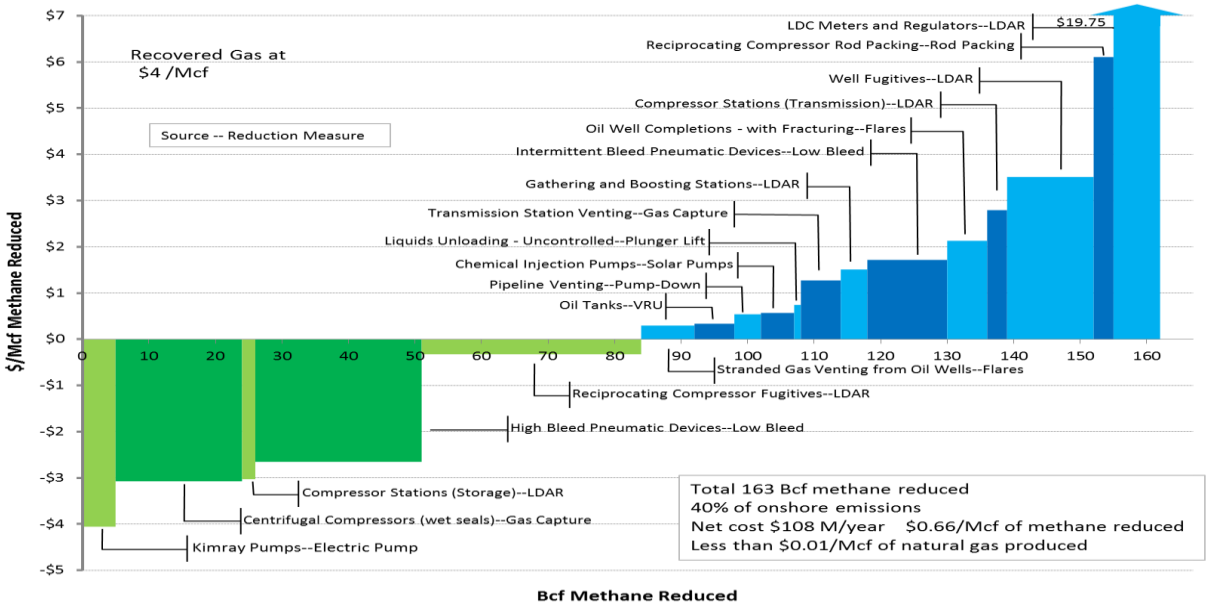
We know the technologies/solutions to reduce these emissions.

1. Production Emissions*	2. Transmission & Storage Emissions*	3. Local Distribution Emissions*
Pneumatic controllers = 600 Equipment leaks = 307 Liquid unloadings = 270	Reciprocating compressors = 366 Equipment leaks = 353 Uncombusted methane in exhaust = 117	Pipeline Mains = 132 Service pipelines = 63.6 M&R Facilities = 42.3

*Gg 2012 CH4

2. … and 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.



Studies in Canada and Mexico show similar cost-effective reductions are achievable in those countries as well.

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.

EDF Working to Drive Innovative Techniques

1

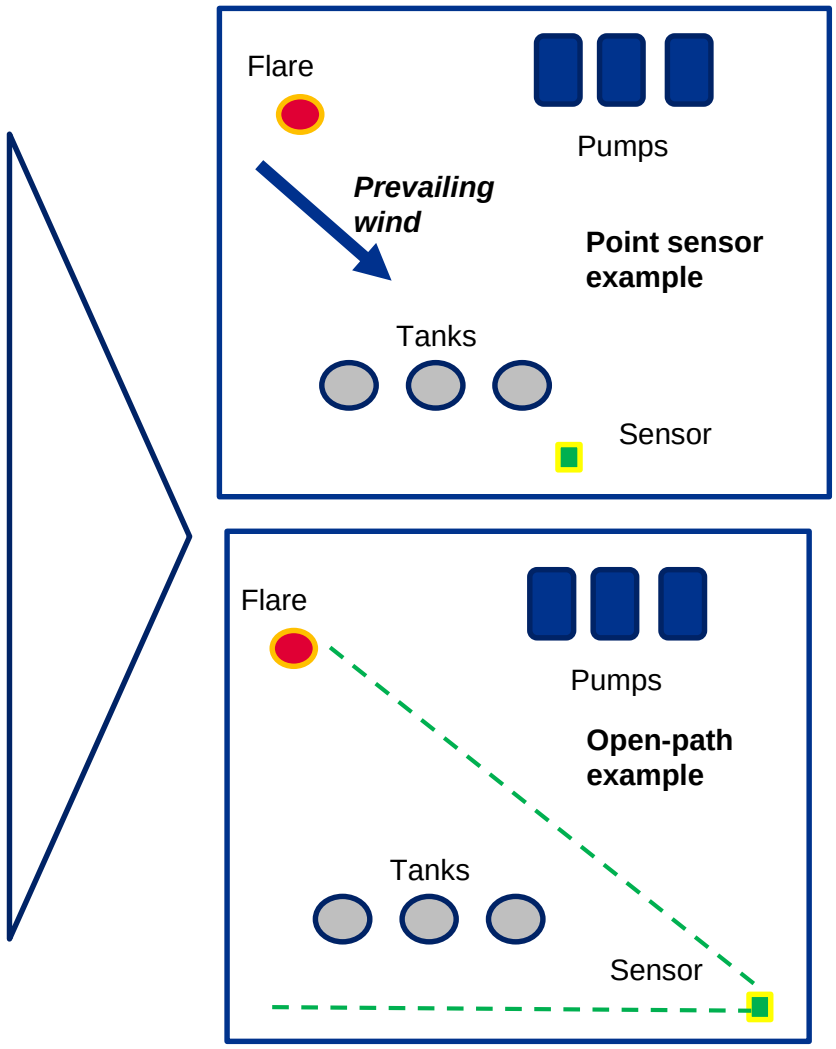
Methane Detector Challenge

2

Local Gas Utility Pipe Repair and Replacement Prioritization

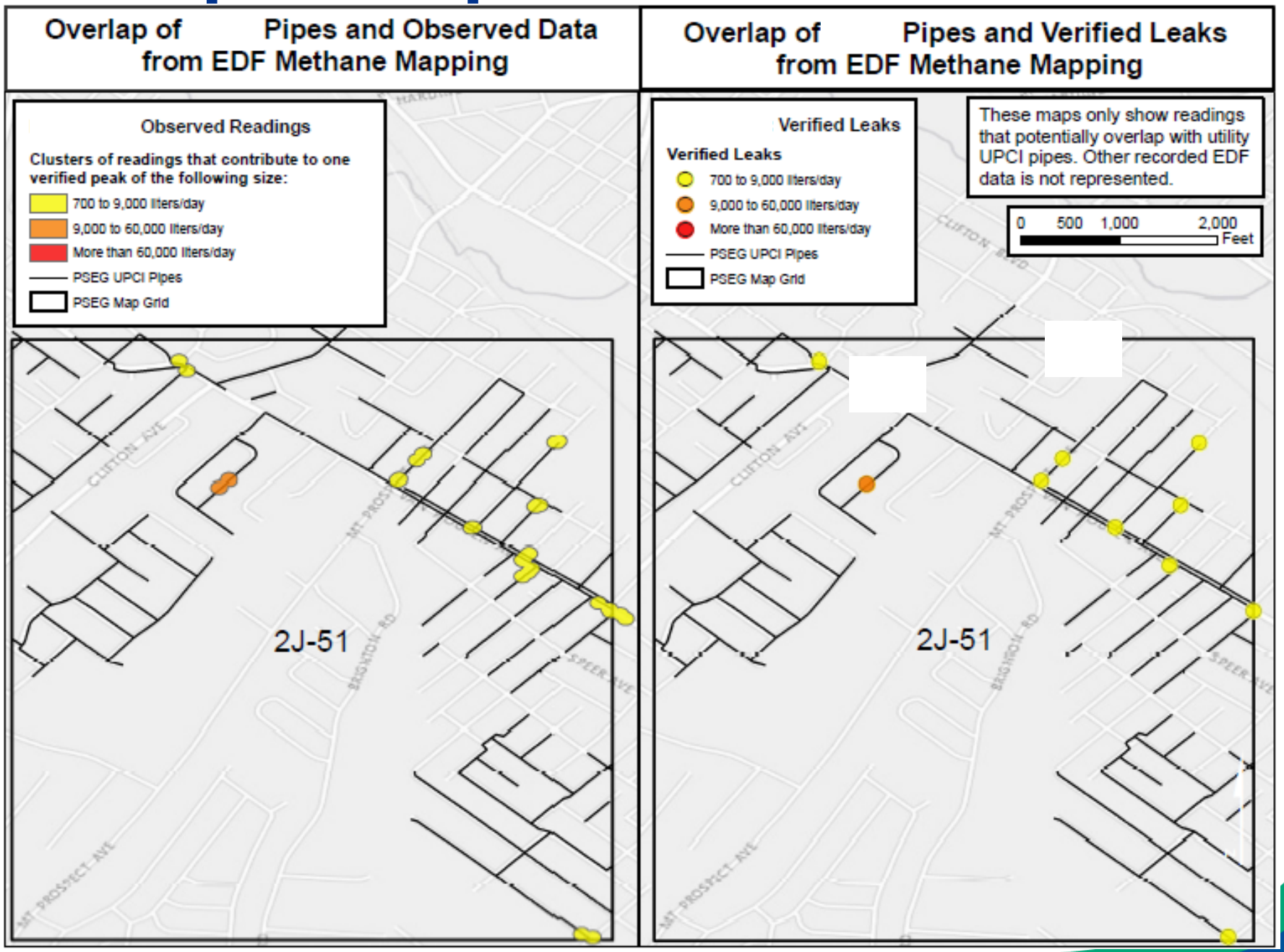
1. Methane Detector Challenge

EDF and partners designed and tested low-cost continuous methane monitors. Field pilots this summer.



A low-cost monitor at every site could more quickly identify leaks/emissions and prompt fixes.

2. Repair/Replace Prioritization



Questions?

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Sources

- **Climate Implication of Methane**: WORKING GROUP I CONTRIBUTION TO THE IPCC FIFTH ASSESSMENT N.p., 23 Sept. 2013. Web. 30 July 2014. http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_All.pdf. Table 8.7 page 8-58.
- **Global Methane Leak Data:** Rhodium Group analysis of global methane leaks: http://rhg.com/reports/untapped-potential
- **Value Chain Leak Graphic:** Brandt, et al http://science.sciencemag.org/content/343/6172/733.full-text.pdf+html
- **1.7% Leak Rate:**
  - **1.7 %** https://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2016-Main-Text.pdf
  - **Equivalencies from EPA GHG Calculator**: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator
  - **Cars**: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_11.html
  - **Coal Plants**: http://www.climatecentral.org/news/flurry-of-coal-power-plant-shutdowns-expected-by-2016-17086
  - **1.7**: $1.7 billion comes from June 2013-June 2014 avg. henry hub price ($4.31/Mmbtu) $6.2 is Japanese avg. import price June 2013-June 2014.
- **ICF Cost Curve:** https://www.edf.org/energy/icf-methane-cost-curve-report