



The Climate Effects of Fracking

evidence from the US

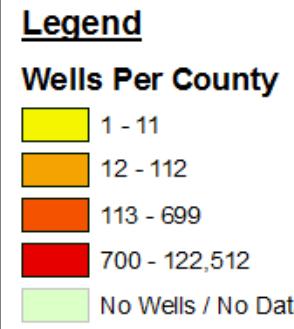
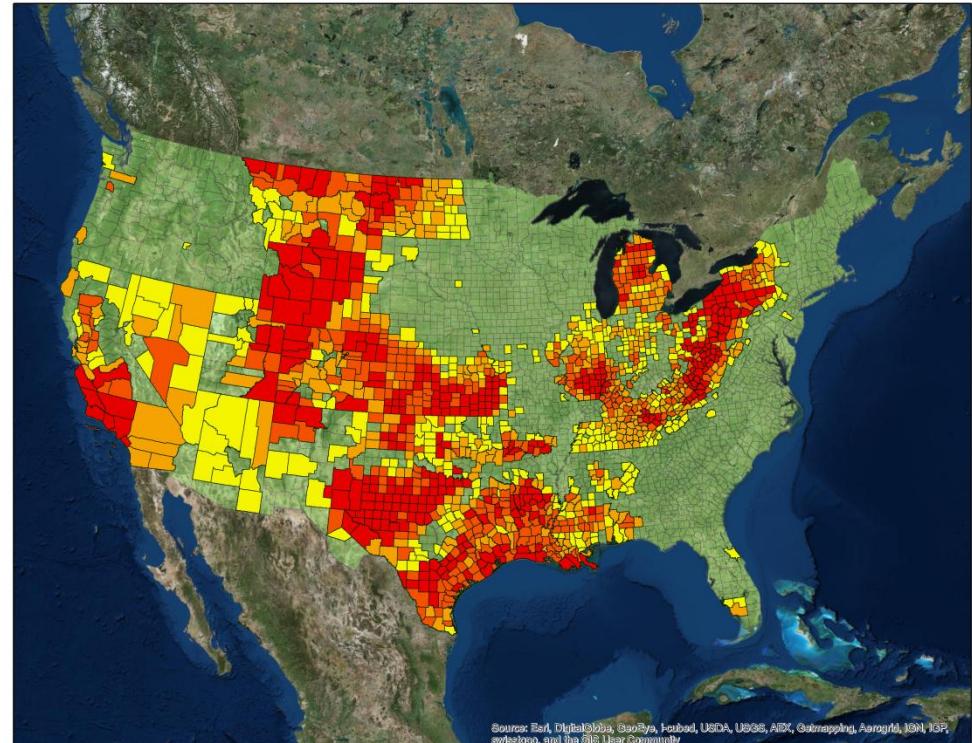
Max Gruenig
September 2015

Does fracking kill the climate?

GHG emission Sources :

- exploration
- extraction
- transport + storage
- abandoned wells

>> methane has
72times global
warming potential of
CO2 over 20 years



FracTracker Alliance

ourenergysolutions.org

How bad is bad?

- Global atmospheric CH₄ concentrations rise since 2007
- Significant discrepancies between emission inventories
- Official statistics (such as EPA) generally rely on conservative estimates



Discrepancies linked to different methodological approaches (atmospheric or at site measurements) and different practices in extraction and processing across the industry (flaring, venting, etc.)

Flaring © FracTracker

How much is leaking?

Brandt et al. investigated in 2014 the actual CH₄ leakage compared to official inventories based on a total of 22 studies

„Methane emissions from U.S. and Canadian natural gas systems appear larger than official estimates.”

>> inventories are inaccurate, bottom-up measurements costly
natural gas and oil sectors identified as important contributors

evidence suggests that **small number of high emitters causes the majority of leakage**

>> opportunity for high-impact mitigation measures

Brandt, A.R., G.A. Heath et al. (2014) *Methane leaks from North American natural gas systems*. Science (343) 733-735. DOI: [10.1126/science.1247045](https://doi.org/10.1126/science.1247045)



Atmospheric measurement

Caulton et al. (2014) use aircraft to measure CH₄ flows in Pennsylvania in 2012.

large regional flux of 2-14 g CH₄ /s /km² for 2,800 km² (matching bottom-up inventories)

large emissions of 34g CH₄ /s /well for 7 well pads

~1% of wells causing 4-30% of the total observed flux

resulting leak rate of 3-17%, midrange 7%

emissions during the drilling stage 2 to 3 orders of

magnitude larger than inventory estimates

if global shale gas production reaches 23 trillion ft³/yr

then the global leak is 24 Tg CH₄ = 4% of current total
global CH₄ emission rate.

Caulton, D. R., Shepson, P. B., Santoro, R. L., Sparks, J. P., Howarth, R. W., Ingraffes, A. R., Cambaliza, M. O. L., Sweeney, C., Karion, A., Davis, K. J., Stirm, B. H., Montzka, S. A., Miller, B. R., 2014. *Toward a better understanding and quantification of methane emissions from shale gas development*. PNAS, Early edition.



Aggregation of emissions

Fritzsche et al. aggregated the results of various studies for ExxonMobil: total life-cycle GHG emissions (expl., prod., proc., trans.&distr.) (lower heating value) based on 2011

2011 US studies: **15.4 to 41.1 g CO₂equ / MJ**

2011 UK studies: **15.4 to 41.1 g CO₂equ / MJ**

2012 EU studies: **4.0 to 11.4 g CO₂equ / MJ**

EU studies assume no or only minimal CH₄ leakage.

also considered for comparison:

one study by Shell (2011) and

two previous German studies

(Fritzsche and Herling 2012; IINAS 2014)

Fritzsche, U. R., Hunt, S., Fingermann, K., 2014,
Comparison of GHG emissions from unconventional
natural gas ("fracking") in key studies. Prepared for
ExxonMobil Production Germany.



Aggregation of emissions

Resulting life-cycle GHG emissions for electricity from shale gas:

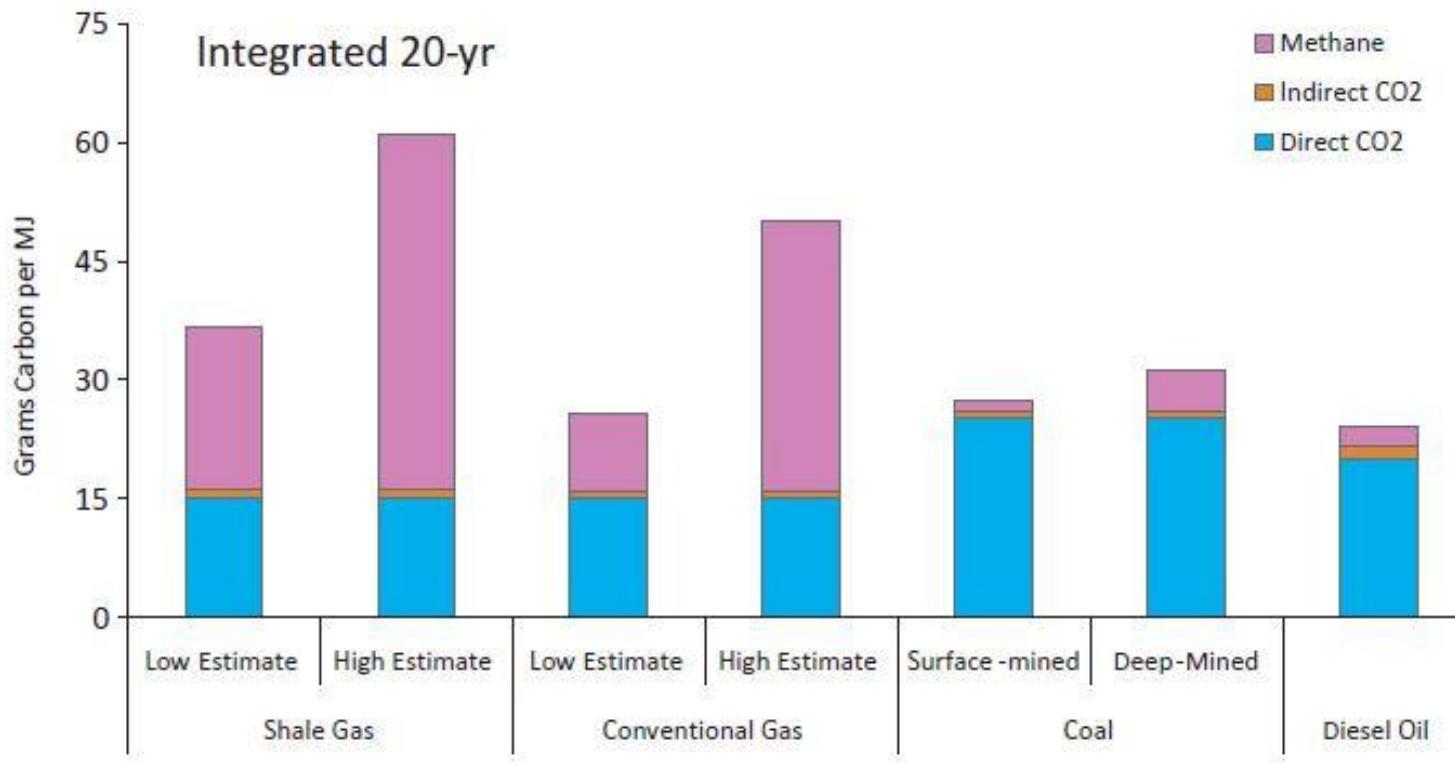
CO2eq in g/kWhel	low	base	high
US studies	454	508	578
UK studies	445	521	597
EU studies	396	410	446
Shell study	492	499	770
DE 2012	527	558	1146
DE 2014	417	526	569

Fritsche, U. R., Hunt, S., Fingermann, K., 2014,
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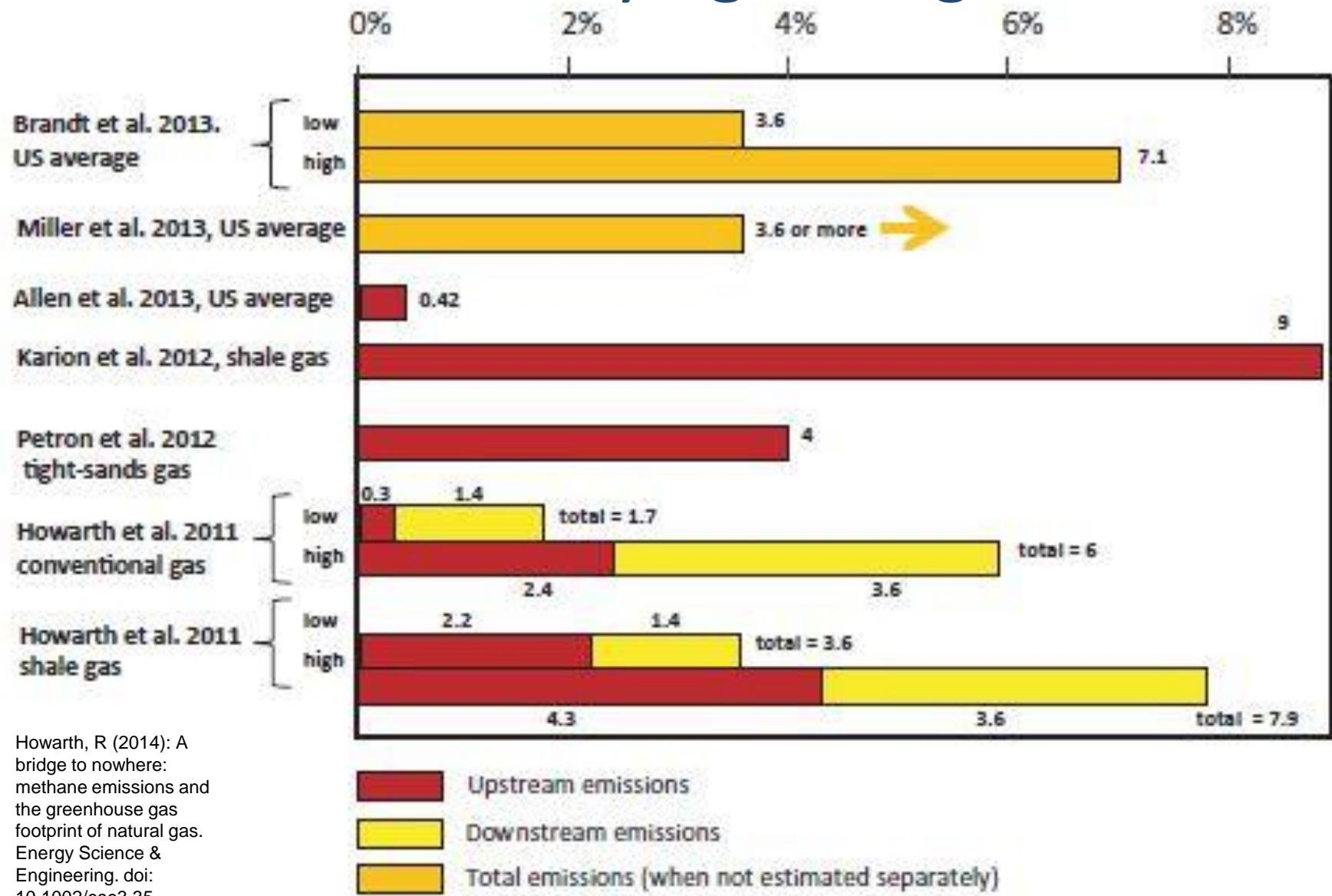
Comparing natural gas to coal and oil

Howarth (2014) concludes that for a 20 yr time horizon, both shale and conventional natural gas have higher GHG emissions than coal or oil:



Howarth, R (2014): A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural gas. Energy Science & Engineering. doi: 10.1002/ese3.35

Quantifying leakage



Howarth, R (2014): A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural gas. Energy Science & Engineering. doi: 10.1002/ese3.35

leak rates and
coal-to-gas
conversion rates
determine
if and when gas
is better than
coal

Nuanced picture?

What Is the Global Warming Impact of Switching Coal Power to Natural Gas?

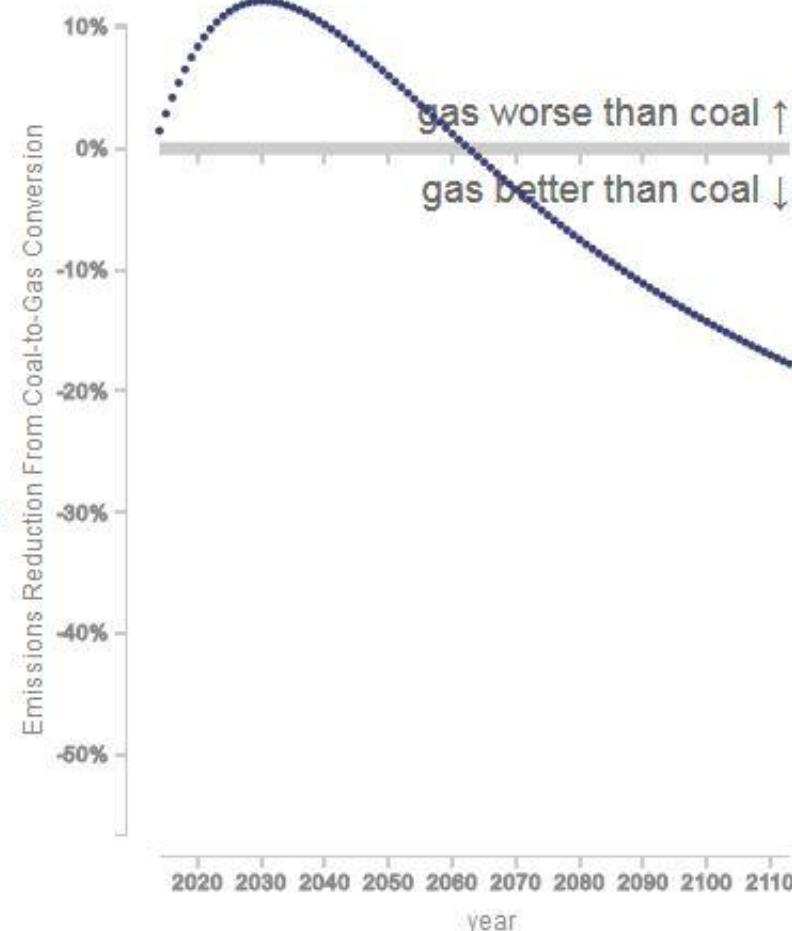
Click below on a leak rate and a coal-to-gas conversion rate to explore different scenarios.

Methane leak rate (%):

1.0%
2.0%
3.0%
4.0%
5.0%
6.0%
7.0%
8.0%

Coal-to-gas conversion rate (% per year):

1.0%
2.0%
3.0%
4.0%
5.0%
6.0%
7.0%
8.0%
9.0%



<http://www.climatecentral.org/news/fracking-methane-emissions-catastrophe-17439>

Conclusion

IPCC (2007): methane emissions contribute 1 out of a total of 2.29 W/m² radiative forcing.

Natural gas can only contribute to mitigating climate change if leakage is kept below 3.2% and only for electricity generation.

In all other cases, coal and oil fare better (near term).



David Gilkey/NPR. May 2012.
<http://www.npr.org/2012/05/16/152204584/towns-effort-to-link-fracking-and-illness-falls-short>

Impact on the energy system

McJeon et al. (2014) ran five models for 2050 and found that

Total fossil fuel GHG emissions are comparable with or without major use of unconventional oil and gas

Fracking will not necessarily reduce GHG emissions.
Fracking displaces all other energy sources, esp. coal, but also renewables.

Max. CO₂ reduction with 100% natural gas is 20%
Realistic reduction is a fraction of the above
Lower natural gas prices discourage energy efficiency
>> increased energy use

McJeon, H., Edmonds, J., Bauer, N., Clarke, L., Fisher, B., Flannery, B.P., et al., 2014. Limited impact on decadal-scale climate change from increased use of natural gas. *Nature* 514, 482–485.



Indirect climate change impacts



Land use change, loss of carbon sequestration potential

Increased road transport GHG emissions

Diverting of investments from renewables and energy efficiency

Lock-in into fossil fuel infrastructure

<http://www.alleghenyfront.org/story/no-health-registry-pa-doesn%E2%80%99t-know-impact-fracking-health>

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eius.org

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Sources

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