

Natural Gas Pipeline Leaks and Emissions



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HEJC

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References

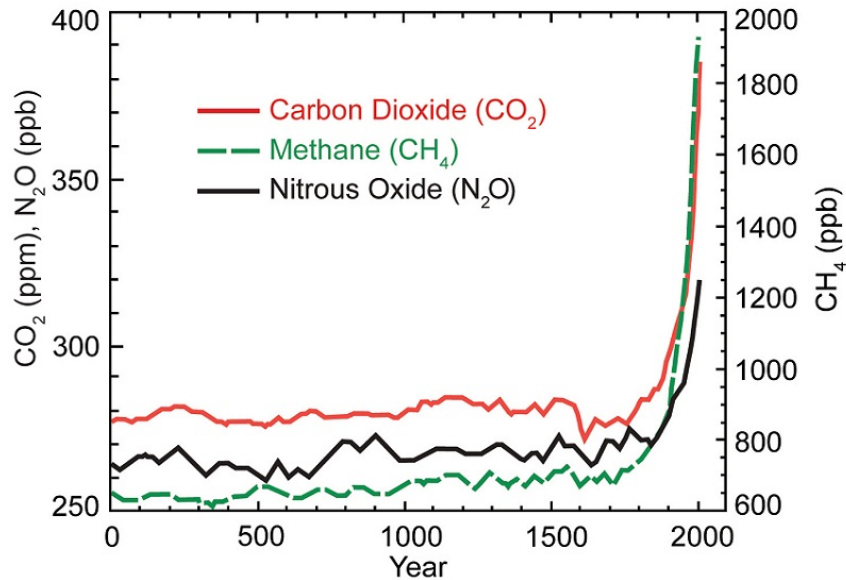
All data in these slides comes from the following sources:

- “America Pays for Gas Leaks: Natural Gas Pipeline Leaks Cost Consumers Billions” - A report prepared for Sen. Edward J. Markey.
- Energy Information Administration website. <https://www.eia.gov/>
- “Causes of Climate Change.” <http://www3.epa.gov/climatechange/science/causes.html>
- Natural gas production chart: <http://www.eia.gov/dnav/ng/hist/n9050us2a.htm>
- Natural gas production and distribution map: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/process.html
- <http://www.iea.org/newsroomandevents/news/2015/march/global-energy-related-emissions-of-carbon-dioxide-stalled-in-2014.html>
- Nisbet *et al.* (2014), “Methane on the Rise—Again.” *Science*, Vol 343, 31 JANUARY 2014.
- McKain *et al.* (2015), “Methane emissions from natural gas infrastructure and use in the urban region of Boston, Massachusetts.” *PNAS*, vol. 112, no. 7, 1941–1946, February 17, 2015.
- Brandt *et al.* (2014), “Methane Leaks from North American Natural Gas Systems.” *Science* Vol 343, 14 February 2014.
- Conservation Law Foundation. <http://clf.org/map/>
- “Governor Patrick Signs Legislation to Address Gas Leaks.” *Patch*. <http://patch.com/massachusetts/salem/governor-patrick-signs-legislation-to-address-gas-leaks>
- “Massachusetts Governor Signs Gas Leaks Bill; More Work Needed to Address Cost, Climate Impact.” *Clean Water Action*. <http://www.cleanwateraction.org/press/massachusetts-governor-signs-gas-leaks-bill-more-work-needed-address-cost-climate-impact-0>
- “Bill H.2950, 188th (2013 - 2014). An Act relative to natural gas leaks.” *The 189th General Court of the Commonwealth of Massachusetts*. <https://malegislature.gov/Bills/188/House/H2950>
- “Tennessee Gas Pipeline Co. files environmental report with Federal Energy Regulatory Commission”. *Mass Live*. http://www.masslive.com/news/index.ssf/2015/03/tennessee_gas_pipeline_co_file.html
- “In face of opposition, company to reroute gas pipeline”. *Boston Globe*. <https://www.bostonglobe.com/business/2014/12/05/face-opposition-company-reroute-pipeline/wj0k4WbfYr5FFyyHtPmFGJ/story.html>

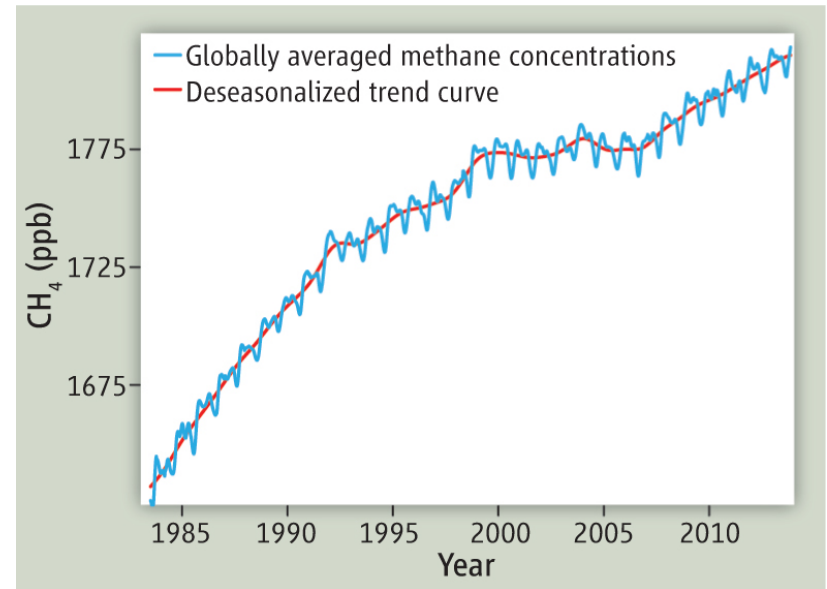
Natural Gas vs. CO₂

- Natural gas: primarily methane CH₄.
- Global average atmospheric levels:
 - CO₂ ~ 400 ppm = 400,000 ppb.
 - CH₄ ~ 1,800 ppb = 0.45% of CO₂ levels.
- Lifespans:
 - CO₂: centuries
 - CH₄: decades (half life of 7 years in atmosphere)
 - Natural gas is a much more potent greenhouse gas than CO₂
 - ~20-25 times more over the long term (100 years).
 - ~72 times more over a 20 year horizon.

Natural gas production and atmospheric methane levels.



“Causes of Climate Change.” <http://www3.epa.gov/climatechange/science/causes.html>

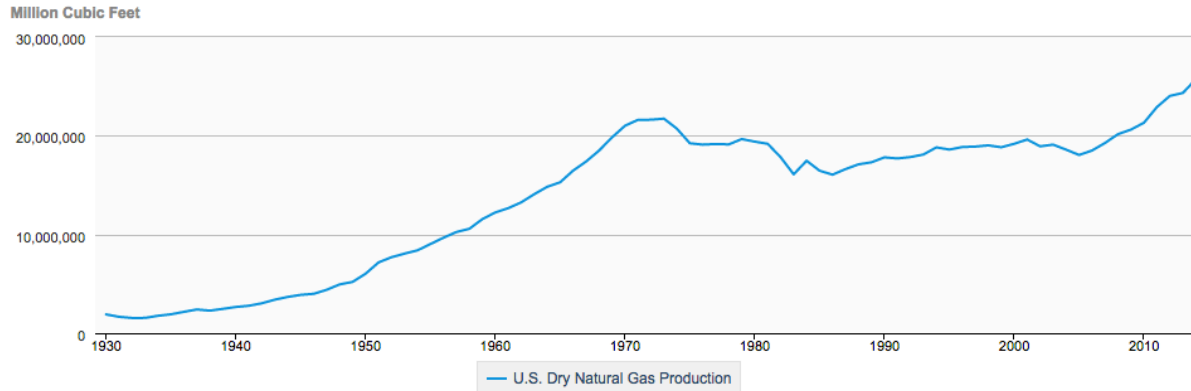


Nisbet *et al.* (2014), “Methane on the Rise—Again.” *Science*, Vol 343, 31 JANUARY 2014.

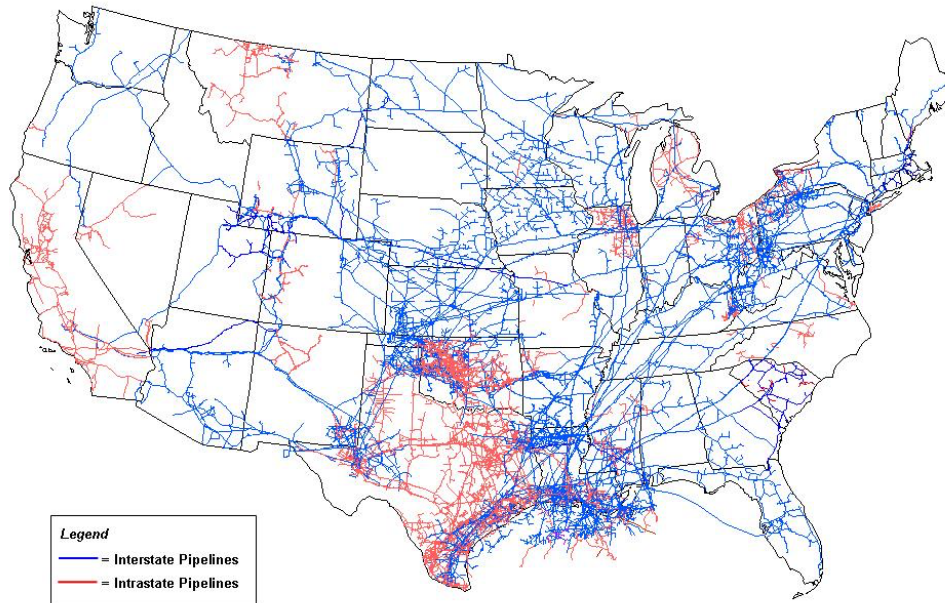
- Methane levels have steadily risen since the start of the industrial revolution in 1750.
- Levelled off in the early 2000s.
- Started rising again in the late 2000s (due to the natural gas boom??)

U.S. natural gas production and pipelines

U.S. Dry Natural Gas Production

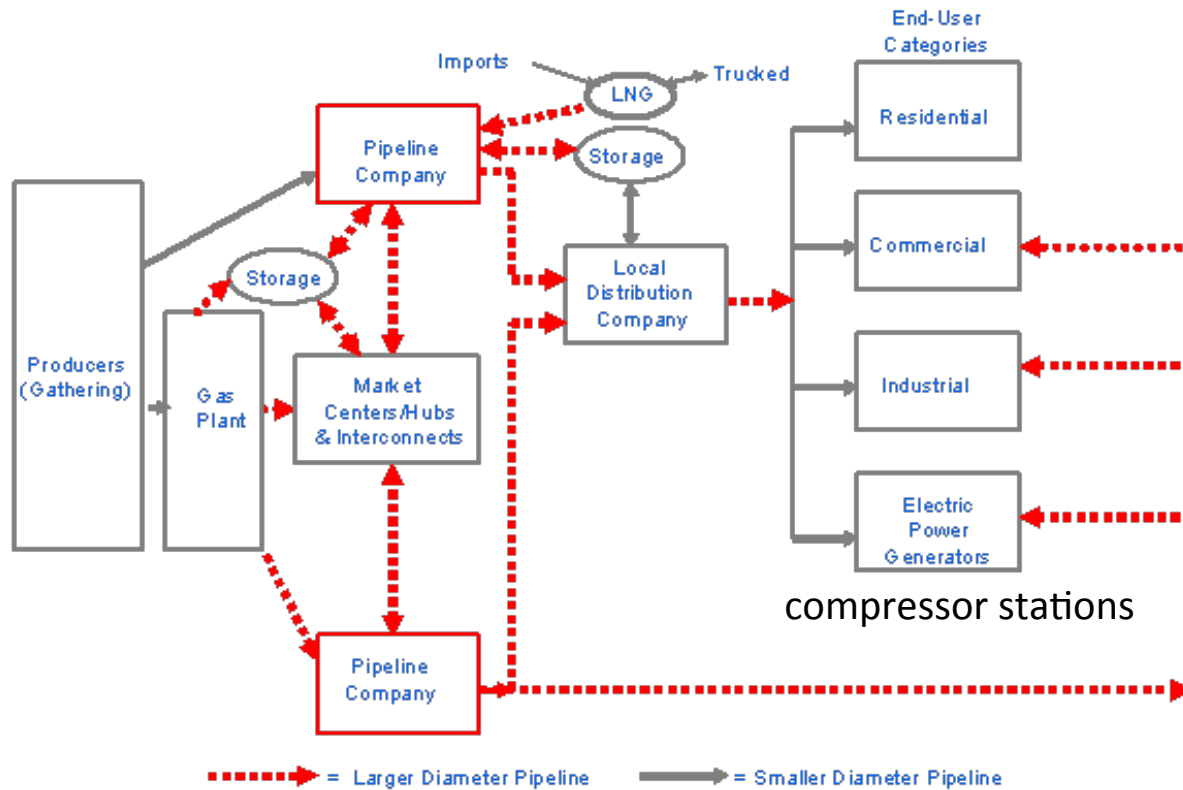


Natural gas production chart:
<http://www.eia.gov/dnav/ng/hist/n9050us2a.htm>



Pipeline map: http://www.nbcnews.com/id/39174246/ns/us_news/t/most-us-gas-lines-not-inspected-latest-technology/#.VQXfgxDF8T8

Natural gas production and distribution



Natural gas production and distribution map: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/process.html

Source: Energy Information Administration, Office of Oil and Gas

Pipeline infrastructure is vast and distributed – companies control many different geographic regions and different types of pipes (material, age, size, miles of piping).

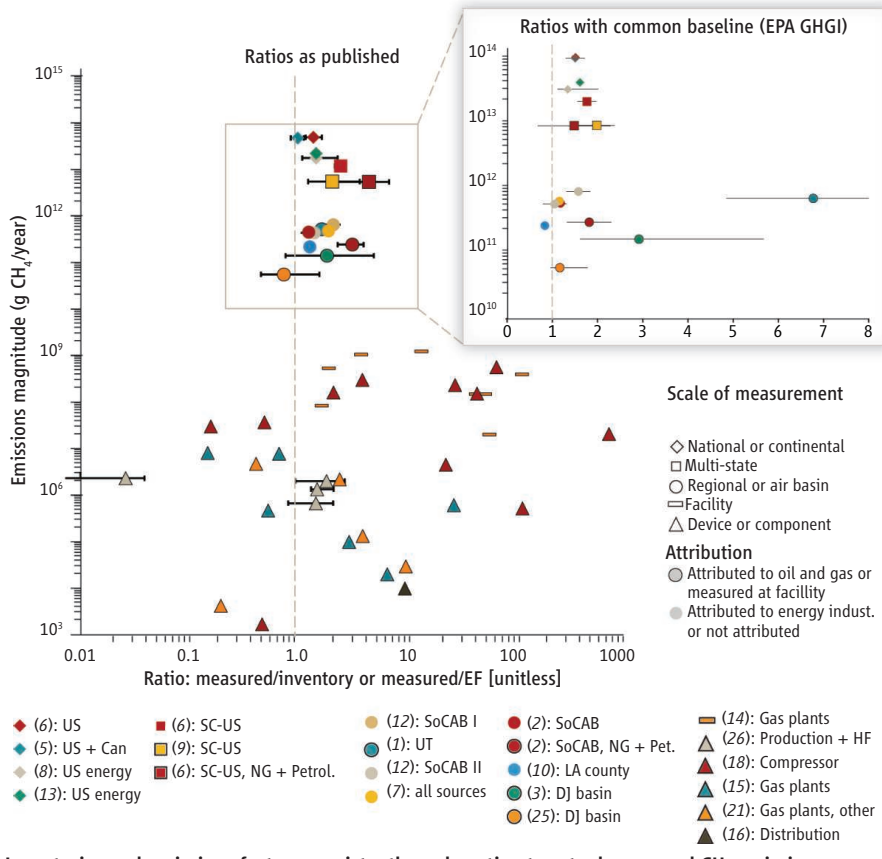
Unaccounted for natural gas

- Gas distribution companies in 2011 reported releasing **69 billion cubic feet** of natural gas to the atmosphere.
 - Almost enough to meet the state of Maine's gas needs for a year.
 - Equivalent to **~33.3 million metric tons of CO₂**.
 - Equivalent to CO₂ emissions of ~ 6-7 million automobiles.
 - Reference: CO₂ emissions in 2014: **32.3 billion metric tons**
 - Natural gas released contributes equivalent of only **~0.1%** of total CO₂ emissions.
- Natural gas unaccounted for in 2000-2011:
 - U.S.: 2.6 trillion cubic feet
 - Massachusetts: 99 - 227 billion cubic feet of natural gas
 - Natural gas distribution systems (main pipelines and smaller distribution networks and mains): **19%** of total CH₄ emissions from natural gas systems.

Conversion factor assumptions:

- 1 billion cubic feet CH₄ = 19,300 metric tons CH₄
- 1 metric ton CH₄ = 25 metric tons CO₂ equivalent
- 1 billion cubic feet CH₄ = 482,500 metric tons CO₂ equivalent

Atmospheric natural gas measurements vs. claimed emissions factors



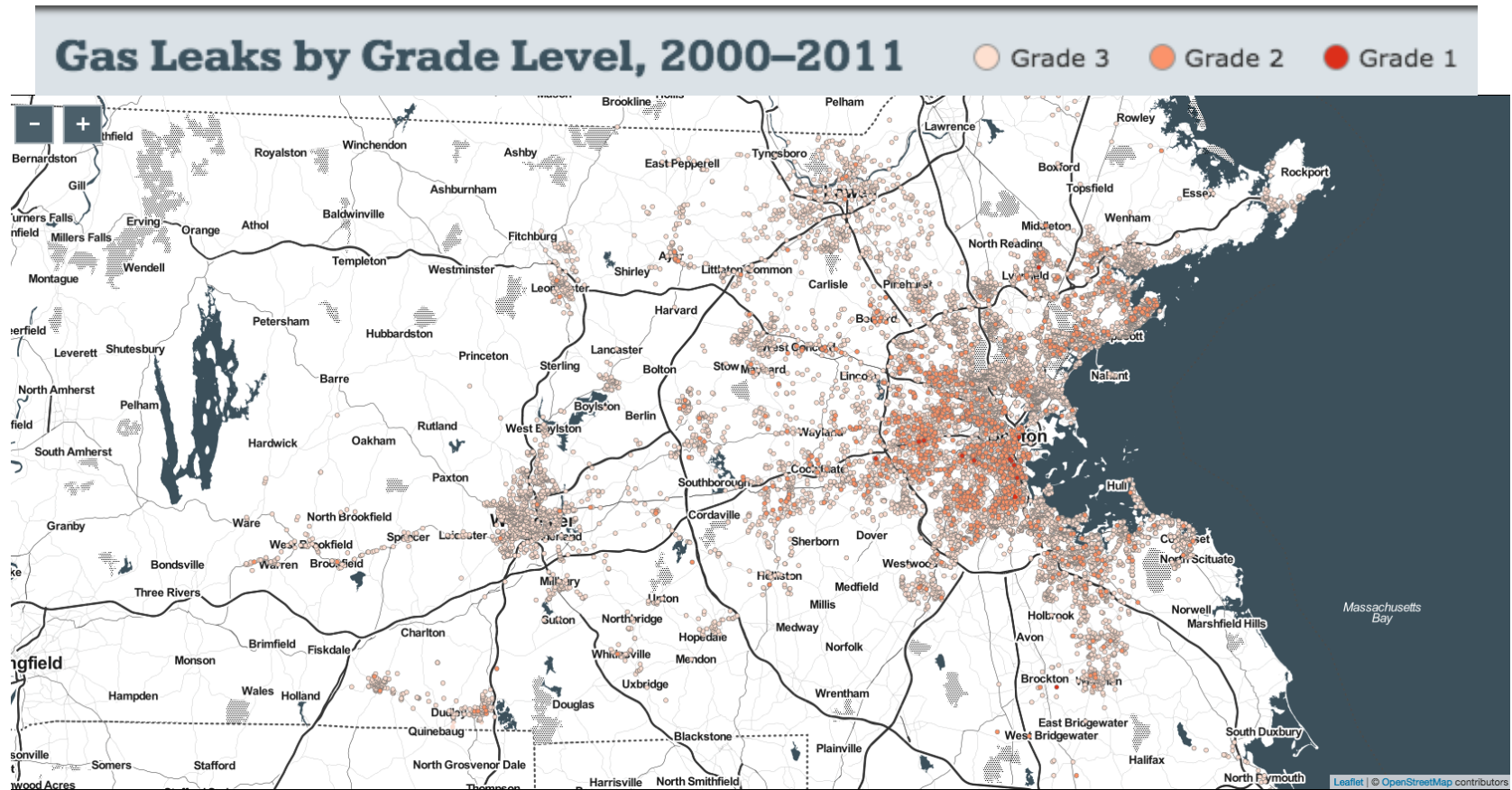
- Emissions factor (EF): estimated emissions per device.
- Inventory: EF x number of devices
- Ratio >1 indicates emissions are larger than expected from emissions factor or inventory claimed.

Summary of studies:

- Emissions are overall underestimated.
- State and regional studies predict larger underestimation than national studies.
- National studies, which average outliers better, suggest 1.25-1.75 times the emissions than expected from the green house gas inventory of the EPA.

Challenge: attributing CH₄ emissions to multiple potential sources (anthropogenic and natural).

Reported gas leaks in Massachusetts



Grade 1 – hazardous

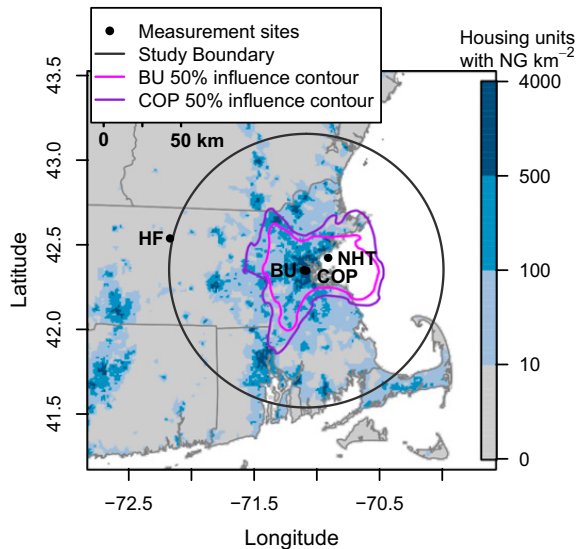
Grade 2 – potentially hazardous

Grade 3 – non-hazardous

Companies often ignore grade 3 leaks.

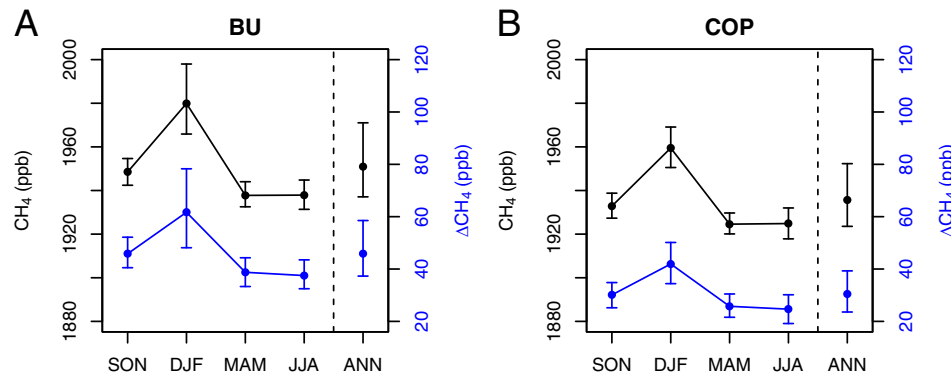
But in aggregate they can make significant contributions to CH₄ emissions.

Quantitative study of gas leaks in the Boston area

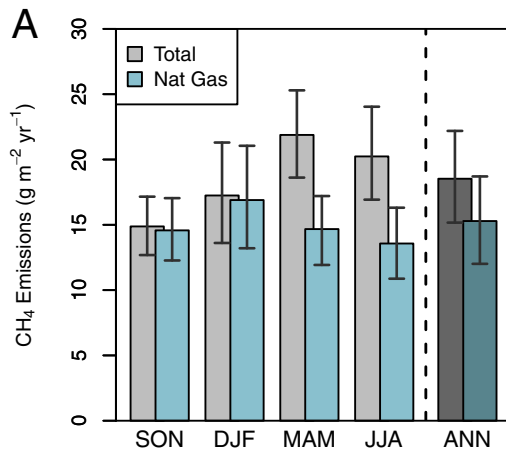


- Atmospheric CH₄ concentrations measured continuously from Sep 2012 to Aug 2013 at four locations:
 - Two urban centers: BU and Copley
 - Two locations outside Boston: Harvard Forest and Nahant
 - Random sampling over 48 h periods to get background concentrations

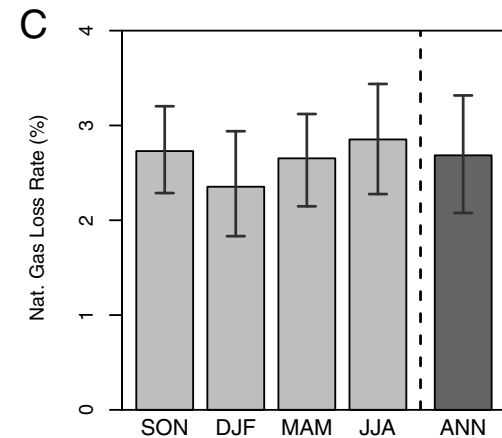
- Values of ΔCH_4 calculated by subtracting background from urban concentrations.
- Hourly average ΔCH_4 data aggregated into daily afternoon means (11-16 h EST).



Quantitative study of gas leaks in the Boston area



Ratio of C₂H₆ to CH₄ determines proportion of natural gas contribution to CH₄ emissions



- Leak rate corresponds to ~300,000 metric tons of natural gas leaked over the 2012-2013 year studied — about **2.7 %** of all natural gas delivered to the region of study.
 - 7.5 million metric tons CO₂ equivalent or CO₂ emissions from ~1.5 million passenger vehicles.
 - Gas valued at \$90 million and could heat 200,000 homes in a year.
- State and federal authorities previous estimate: **1.1 %** of natural gas was being lost to leaks from a range of sources in the area, including homes, businesses, and electricity generation facilities.
- If correct, Boston area would be contributing **9% of U.S. methane from natural gas** – implies national estimate is also low.

Primary cause of natural gas leaks – old infrastructure

- Cast iron and bare steel:
 - Leak 18 times more gas than plastic pipes.
 - Leak 57 times more gas than protected steel.
- In 2012, Massachusetts had:
 - 5,482 miles of leak-prone mains.
 - 194,326 miles of leak-prone service lines.

2013 Massachusetts State Rank for Pipeline Material	
Rank	Item
2	Most miles of cast iron service lines
3	Most miles of cast iron mains
4	Most miles of bare steel service lines
9	Most miles of bare steel mains
6	Most miles of pipeline from cast iron and bare steel

Lack of incentives to repair “minor” leaks

Company Name	Leak-prone Pipeline Replaced Since 2004	Replacement rate								Leak-prone Pipeline Remaining in 2012
		2005	2006	2007	2008	2009	2010	2011	2012	
Massachusetts - Main Miles	1,293	-3%	-3%	0%	-2%	-2%	-3%	-3%	-4%	5,571
Massachusetts - Service Lines	28,419	-2%	-4%	-2%	-3%	-4%	-3%	0%	-4%	194,326
National- Main Miles	20,944	-5%	-3%	-3%	-2%	-4%	3%	-4%	-3%	93,705
National- Services	2,036,032	-10%	4%	-2%	-2%	-4%	-35%	-4%	-12%	2,568,279

- In many states, gas companies pass on the cost of lost gas to customers.
 - **Massachusetts customers lost \$640 million to \$1.5 billion from 2000-2011 due to leaked gas.**
- Replacing old pipes requires significant upfront capital.
 - 33 states, including Massachusetts, have infrastructure replacement programs.
 - But still little incentive to accelerate pipeline replacement so long as companies can still pass costs on to customers for lost gas.
- Only two states, Pennsylvania and Texas, have established limits on the amount companies can charge customers for lost gas.
 - Texas: 2010 to 2012 gas companies reduced their inventory of leak-prone service lines by **55 percent (101,790 lines)**.
 - In this same time period, gas companies in Massachusetts reduced their leak-prone service lines by just **4 percent (8,278 lines)**.
- As of 2013, only five states required all non-hazardous leaks to be repaired within a certain timeframe.

Methods to detect and reduce pipeline leaks

- Include all emissions sources in inventory for possible leaks, including:
 - downstream of customer meters
 - industrial facilities
 - residential and commercial settings.
- Improve sampling protocols and develop more comprehensive leak surveys.
 - negative unaccounted for gas volumes by companies indicate calculating or reporting errors
 - infrequent high emission events are under-sampled.
 - small leaks require more sensitive equipment to detect
- **Replace old mains and service lines sooner rather than later.**

New MA law to promote repair of pipeline infrastructure

- Passed in July 2014: An act relative to natural gas leaks
 - Grade 1 (hazardous) leaks must be repaired until hazard is eliminated.
 - Grade 2 (potentially hazardous) leaks required to be repaired within a year.
 - Grade 3 (non-hazardous) leaks must be reevaluated.
 - Gas companies accountable for plans to remove leak-prone infrastructure.
- What's still missing:
 - Ratepayers still pay the cost of lost gas.
 - Grade 3 leaks don't actually have to be repaired on any timetable.
 - No requirement to actively replace old cast iron and bare steel pipes without leaks.

"Bill H.2950, 188th (2013 - 2014). An Act relative to natural gas leaks." *The 189th General Court of the Commonwealth of Massachusetts*. <https://malegislature.gov/Bills/188/House/H2950>

"Tennessee Gas Pipeline Co. files environmental report with Federal Energy Regulatory Commission". *Mass Live*. http://www.masslive.com/news/index.ssf/2015/03/tennessee_gas_pipeline_co_file.html

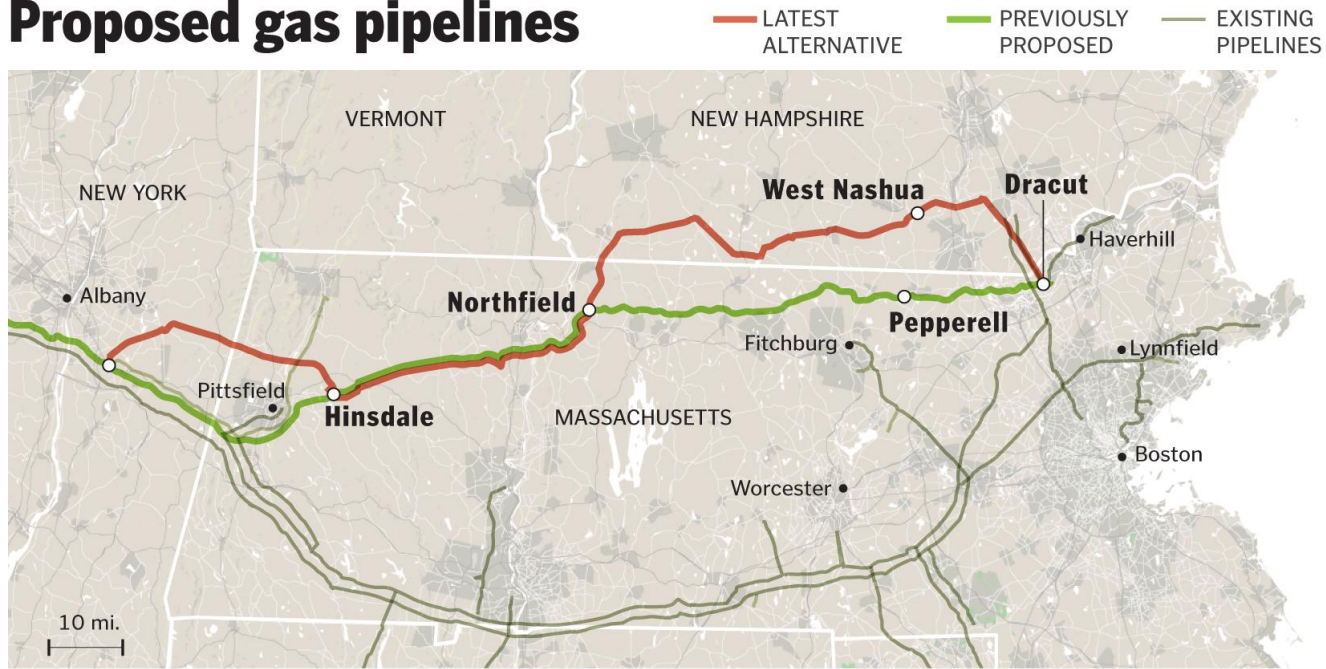
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Optimism for the future?

- Based on EPA assumptions, Massachusetts residents stand to realize **\$156 million** in net benefits over 10 years from the companies participating in MA infrastructure replacement program.
- State law requires Massachusetts to reduce GHG emissions to **25 percent below 1990 levels by 2020.**
- By 2010, Massachusetts had already succeeded in **reducing methane emissions** from the natural gas distribution system **by 14 percent below 1990 levels.**

New pipeline proposal through MA/NH – 2018?

Proposed gas pipelines



SOURCE: Tennessee Gas Pipeline Company

DAVID BUTLER/GLOBE STAFF

- Capacity to transport up to **2.2 billion cubic feet** of natural gas per day from wells in Pennsylvania to markets in the Northeast.
- Co-locating with existing right of way utility corridors.
- 65 and 90 % of affected landowners in MA and NH respectively have not granted permission to enter their land for surveying purposes.
 - Possible eminent domain authority to pursue access to those denied properties if pipeline wins a certificate from federal regulators.

"Tennessee Gas Pipeline Co. files environmental report with Federal Energy Regulatory Commission". *Mass Live*. http://www.masslive.com/news/index.ssf/2015/03/tennessee_gas_pipeline_co_file.html

"In face of opposition, company to reroute gas pipeline". *Boston Globe*. <https://www.bostonglobe.com/business/2014/12/05/face-opposition-company-reroute-pipeline/wj0k4WbfYr5FFyHtPmFGJ/story.html>

Questions?