Natural Gas Pipeline Leaks and Emissions

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References

All data in these slides comes from the following sources:

- Energy Information Administration website. https://www.eia.gov/
- Natural gas production chart: http://www.eia.gov/dnav/ng/hist/n9050us2a.htm
- “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. CO$_2$

- Natural gas: primarily methane CH$_4$.
- Global average atmospheric levels:
  - CO$_2$ $\sim$ 400 ppm = 400,000 ppb.
  - CH$_4$ $\sim$ 1,800 ppb = 0.45% of CO$_2$ levels.
- Lifespans:
  - CO$_2$: centuries
  - CH$_4$: decades (half life of 7 years in atmosphere)
  - Natural gas is a much more potent greenhouse gas than CO$_2$
    - $\sim$20-25 times more over the long term (100 years).
    - $\sim$72 times more over a 20 year horizon.
Natural gas production and atmospheric methane levels.

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

“Causes of Climate Change.” [Link](http://www3.epa.gov/climatechange/science/causes.html)

U.S. natural gas production and pipelines

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


Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System
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 greenhouse gas inventory of the EPA.

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

Reported gas leaks in Massachusetts

Gas Leaks by Grade Level, 2000–2011

- 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 CH$_4$ emissions.

Quantitative study of gas leaks in the Boston area

- Atmospheric CH$_4$ 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 $\Delta$CH$_4$ calculated by subtracting background from urban concentrations.
- Hourly average $\Delta$CH$_4$ data aggregated into daily afternoon means (11-16 h EST).

Quantitative study of gas leaks in the Boston area

- 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.

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<tr>
<th>2013 Massachusetts State Rank for Pipeline Material</th>
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Lack of incentives to repair “minor” leaks

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.

“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
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?

- 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.

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“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
Questions?