

STUDY

Downstream natural gas composition across U.S. and Canada: Implications for indoor methane leaks and hazardous air pollutant exposures

► Background

The natural gas used in millions of homes across North America is made up of methane, a powerful climate pollutant, and trace amounts of a range of hazardous air pollutants, including the known human carcinogen benzene.

Because natural gas is odorless and used in people's homes, federal regulation in the United States requires that it contain enough odorant to be detectable by people with a "normal sense of smell." However, research has shown that gas leaks from stoves, water heaters, and other residential appliances are common, despite the presence of odorants. This study, published in *Environmental Research Letters*, is the first to assess whether odorant concentrations are protective against elevated levels of benzene exposure, and provides the most comprehensive data to date on natural gas composition.

► Methods

Researchers from PSE Healthy Energy and Stanford University collected 257 samples of unburned NG from stoves in three Canadian and seven U.S. cities, conducted quality control, then combined with 335 samples previously collected from six Californian cities and throughout Greater Boston. Using these samples, they tested natural gas for hazardous air pollutants and odorant concentrations. Based on their findings, researchers assessed whether gas leaks could elevate indoor benzene concentrations without being detected by smell. Cities included in the study:

- Houston, TX
- Indianapolis, IN
- Chicago, IL
- Denver, CO
- Washington, DC
- Pittsburgh, PA
- New York, NY
- Greater Boston, MA
- Multiple cities across California
- The Canadian cities of Vancouver, Toronto, and Calgary



KEY TERMS

Benzene

Benzene is a volatile organic compound that is classified as a known human carcinogen by the United States Environmental Protection Agency.

Methane

Methane is the primary component of natural gas. It is also a powerful climate pollutant.

Odorants

Odorganosulfur compounds are commonly added to natural gas to give it its rotten egg smell.

➤ Key Findings

The natural gas used in homes across North America contains benzene and other hazardous air pollutants. Researchers found hazardous air pollutants in over 99% of samples across North America. Benzene, a known carcinogen, was found in 97% of samples.

Why it Matters:

- These findings suggest that benzene and other hazardous air pollutants are present in nearly all natural gas supplied to households, buildings, and businesses throughout North America.
- This confirms previous research that suggests natural gas leaks may pose risks for public health, as well as the climate.

The concentration of both odorants and pollutants vary by location.

Researchers found that the composition and concentration of gas odorants, as well as the hazardous air pollutants present in natural gas, varied significantly depending on the location. For example, Vancouver, Los Angeles, Calgary, and Denver had at least 2x higher mean benzene concentrations than other cities sampled. Meanwhile some gas samples contained no detectable odorants at all, indicating that a leak would be odorless.

Why it Matters:

- The substantial variability in gas composition indicates a lack of standardization across regions, making it more challenging to effectively predict average exposure levels.

Even people with an average sense of smell are living with gas leaks they cannot smell. For a person with an average sense of smell, the researchers found that gas odorants generally do ensure larger leaks are detected, thereby preventing high levels of benzene exposure. Despite this, the researchers found that many people are likely living with gas leaks they cannot smell. Specifically:

- The researchers found that even for people with an average sense of smell, small gas leaks can go undetected, leading to elevated, potentially persistent indoor benzene levels.
- The average gas stove leak would go undetected, based on previously measured leak rates.
- Many people have less than average smelling sensitivity and are not as well protected by odorant levels. The researchers also found that many people are not average and may not be as well protected.

Why it Matters:

- Gas leaks, both large and small, are common across North America. If these leaks go undetected for long periods, they can impact indoor air quality, the climate, and potentially public health.
- Many gas consumers are living with smaller, hard-to-smell leaks which can act as a persistent indoor benzene source.

REGIONAL INSIGHTS

Benzene Concentrations

Previous research suggests that benzene concentrations in natural gas may vary based on location and over time. Samples taken during this study exhibited variations in the chemical makeup and concentration of both hazardous air pollutants and natural gas odorants. For example, scientists found:

- **Vancouver** and **Calgary** had at least 2x higher mean benzene concentrations than the other cities sampled.
- **Vancouver** exhibited a nearly 50x greater mean benzene level than the lowest-concentration city (Boston).
- **Vancouver, Los Angeles, Calgary,** and **Denver** were among the top five cities for highest mean levels of each benzene, toluene, ethylbenzene, and xylenes compound (BTEX) and hexane.

➤ Key Findings, Cont.

Relying solely on odorants for leak detection puts certain populations at risk of exposure to hazardous air pollutants. Given benzene's toxicity, the wide-ranging ability for the general public to smell gas odorants, the prevalence of indoor gas leaks, and methane's role as a climate pollutant, this study raises concerns that reliance on the average sense of smell may allow some leaks to go undetected, potentially for long periods of time.

- Because natural gas is odorless and used in people's homes, United States regulation requires that it contain enough odorant to be detectable by people with a "normal sense of smell." However, many people do not have an average sense of smell.
- Approximately 3% of Americans have anosmia (no sense of smell) or severe hyposmia (minimal sense of smell).
- At least half of COVID patients experienced smell loss during infection.
- An estimated 31% of adults aged ≥ 70 years misidentify odorized natural gas.

Additionally, many people do not live in average homes. This is important, because the amount of ventilation can play a central role in the level of exposure over time.

Why it Matters:

- These findings raise concern about the sole reliance of smelling gas to protect all gas consumers from all of the risks associated with gas leaks.

➤ Recommendations

This study indicates that benzene and other hazardous air pollutants are present in nearly all natural gas that is supplied to households, buildings and businesses throughout North America, which builds on existing evidence that natural gas leakage poses not only climate, but also human health risks.

Based on their findings, the researchers suggest that regulators and consumers would benefit from greater transparency of natural gas composition, such as open access to natural gas composition data and regular sampling. Additionally, improving leak detection through stricter odorization standards or increased usage of leak detecting devices, or reducing gas use altogether can improve indoor air quality and public health.

ABOUT PSE HEALTHY ENERGY

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