

Benzene and Other Hazardous Air Pollutants in Consumer-Grade Natural Gas in Europe

The global effort to reduce methane emissions has primarily focused on methane’s fast and powerful warming impact on the atmosphere, but these efforts have been blind to the air quality and human health risks of methane emissions. PSE Healthy Energy studies the chemical composition of natural gas and the hazardous air pollutants released alongside methane whenever natural gas escapes, whether it’s from a wellhead, a pipeline, or a common kitchen stove. Our research measures pollutants co-emitted with methane and assesses the associated air quality and human health risks.

PSE Healthy Energy and Stanford University are the first to study the extent to which natural gas leaks from kitchen stoves create health risks in European homes. Our latest study, published in [Environmental Research Letters](#), shows that European gas can contain very high levels of benzene, a known human carcinogen, and that commonly occurring stove leaks can raise indoor benzene concentrations to levels that pose a health risk without residents ever knowing.

Researchers analyzed the chemical composition of European natural gas by testing 72 unburned-gas samples from household stoves across seven cities in Italy, the Netherlands, and the United Kingdom. The analysis included:

- **Measuring hazardous air pollutants in the gas, including the carcinogen benzene**
- **Measuring the amount of odorant added to the gas**
- **In 35 homes, measuring whether stoves are leaking gas, and how much they are leaking**

Combining this information, researchers modeled the extent to which benzene content and gas leaks contribute to hazardous indoor air pollution.

[PSE Healthy Energy \(PSE\)](#) is a scientific research institute generating energy and climate solutions that protect public health and the environment. PSE provides expertise in public health, environmental science, and engineering and brings science to energy policy through actionable research, communications, and advising.

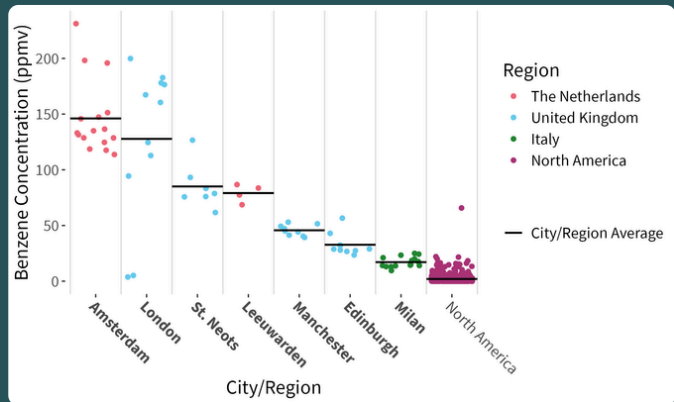
PSE’s [Methane + Health Initiative](#) is a multi-year research initiative to improve the scientific and public understanding of the link between methane emissions, air pollution, and public health.

View the [full study](#).

Here's what was found:

European natural gas contains high benzene concentrations.

Across cities, average benzene-in-gas concentrations ranged from 9 to 73 times the North American average reported in previous research (Rowland et al., 2024). Average benzene concentrations were highest in Amsterdam (146 ppmv) and London (128 ppmv). Milan had the lowest benzene levels of any city tested at 17 ppmv—still almost nine times higher than the 2 ppmv North American average.



Leaks from stoves while the stoves were turned off are common.

Gas leaks from stoves were widespread, with 40% of tested stoves exhibiting a leak. The extent of the leakage varied dramatically, with some stoves showing leak rates orders of magnitude higher than others. Leak rates did not vary significantly between countries.

Modeled indoor benzene levels exceeded health limits in 9% of homes.

Of the 35 homes tested for gas leaks, three had modeled benzene from leaks that exceeded the EU annual limit value of 1.6 ppbv, indicating potential chronic health risk. The largest modeled in-home benzene concentration was 22 ppbv, associated with a stove leak measured in London.

Odorants may not provide adequate warning of hazardous leaks.

Odorant levels in the gas were too low to alert residents to leaks that could create a health risk in the UK and the Netherlands. In Milan, higher odorization and lower benzene meant gas leaks would be detected by smell before indoor benzene concentration surpassed the EU annual limit value.



Image courtesy of Dr. Emily Dowd

Gas Leaks Degrade Outdoor Air Quality and Pose Health Risks to Communities

An outdoor distribution pipeline leak from 2023 in the UK was modeled using the gas composition data collected from stoves. This study found that benzene concentrations were over four times the EU occupational hazard limit near the leak. The leak caused elevated benzene concentrations up to 10 kilometers away.

Natural gas leaks are often framed as a climate or safety issue. This study demonstrates that they are also a human health issue. In parts of Europe, commonly occurring odorless gas leaks can expose people to benzene inside homes at levels exceeding health-based limits, and large outdoor leaks can contaminate air across entire communities.