The Outdoor Pollution is Coming From Inside the House

NATIONAL BUILDING POLLUTION REPORT

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SIERRA CLUB

The Outdoor Pollution Is Coming From Inside The House: National Building Pollution Report

AUTHORS

Amneh Minkara, Sierra Club
Annika Larson, WE ACT for Environmental Justice
Barbara Gottlieb, Physicians for Social Responsibility

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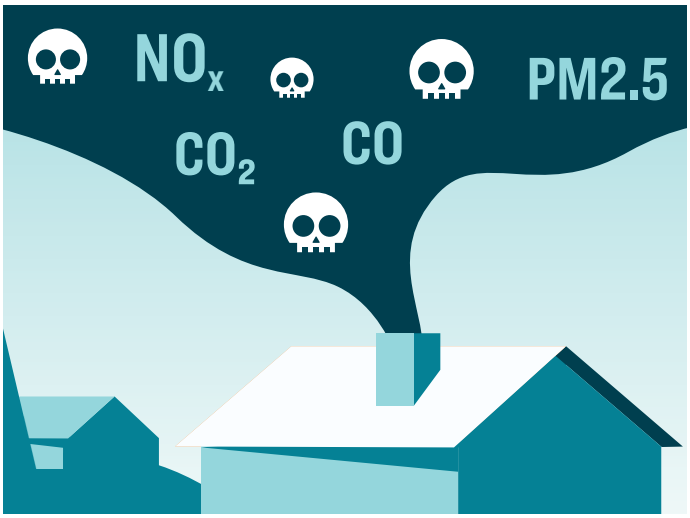
Executive Summary

Fossil fuel combustion in our homes and buildings is an overlooked contributor to public health harms and the climate crisis.

Burning fossil fuels for space and water heating emits health-harming and climate-disrupting pollution, including (but not limited to) nitrogen oxides (NO_x), carbon monoxide (CO), fine particulate matter ($PM_{2.5}$), and carbon dioxide (CO_2).

Although lighting, electronic devices, and most cooling equipment are powered by electricity, **the majority of U.S. buildings still burn fossil fuels to power heating equipment** like water heaters and furnaces. Over two-thirds of greenhouse gas (GHG) pollution from the U.S. residential and commercial buildings sectors result from fossil fuel combustion.
More specifically, **half of U.S. homes** rely on gas as their primary space heating fuel. Gas heating equipment such as water heaters, furnaces, boilers, stoves, and clothes dryers **represent about 80% of fossil fuel-fired building** equipment and emit the majority of direct pollution, including both climate-disrupting GHG pollution and pollution that directly impacts human health. Oil- and propane-burning equipment, which make up most of the remaining 20%, emit dangerous pollutants at **markedly higher rates** than gas equipment.

Pollution from the combustion of fossil fuels in our homes and buildings negatively impacts human health and the climate, and these impacts disproportionately burden vulnerable populations including children, the elderly, low income communities, communities of color, renters, and individuals with pre-existing health conditions. The most recent updates to the Environmental Protection Agency (EPA) **public health** and **climate** pollution inventories show that emissions of harmful pollutants from the building sector – pollutants like nitrogen oxides (NO_x) and carbon dioxide (CO_2) – continue to increase. Global pollution from the building sector hit a **record high** in 2022. In the United States, buildings now account for about **40% of total energy consumption** and **9% of direct greenhouse gas (GHG)** pollution.



Unlike pollution from the energy, transportation, and industrial sectors, **pollution from buildings has been largely ignored by regulators**, a reality that must change if we are to protect public health and welfare and meet our international climate commitments. State and local governments are beginning to take action to address building pollution, and initial funding solutions from the federal government, like the Inflation Reduction Act's **Home Energy Rebates Program**, are beginning to roll out to support the transition to **zero-pollution technology**. However, more action is needed for the country to meet climate, public health, and justice goals.

Table 1: Emissions of Selected Criteria and Greenhouse Gas Pollutants from the Buildings Sector in 2017 and 2020

2017	Residential Buildings	Comm./Institutional Buildings	Buildings Total
Nitrogen Oxides (NO_x)	269,963 tons (2.8% of total NO_x)	191,1127 tons (2% of total NO_x)	461,090 tons **(4.9% of total NO_x)**
Carbon Monoxide (CO)	106,894 tons	143,202 tons	250,096 tons
Particulate Matter ($PM_{2.5}$)	7,566 tons	7,733 tons	15,299 tons
Carbon Dioxide (CO_2)	293 MMT (4.5% of total CO_2)	232 MMT (3.5% of total CO_2)	525 MMT **(8% of total CO_2)**

2020	Residential Buildings	Comm./Institutional Buildings	Buildings Total
Nitrogen Oxides (NO_x)	**280,919 tons (3.6% of total NO_x)**	**200,019 tons (2.6% of total NO_x)**	**480,938 tons (6.2% of total NO_x)**
Carbon Monoxide (CO)	**112,492 tons**	**148,505 tons**	**260,997 tons**
Particulate Matter ($PM_{2.5}$)	6,058 tons	**7,837 tons**	13,895 tons
Carbon Dioxide (CO_2)	**313 MMT (5.2% of total CO_2)**	**229 MMT (3.8% of total CO_2)**	**542 MMT (9% of total CO_2)**

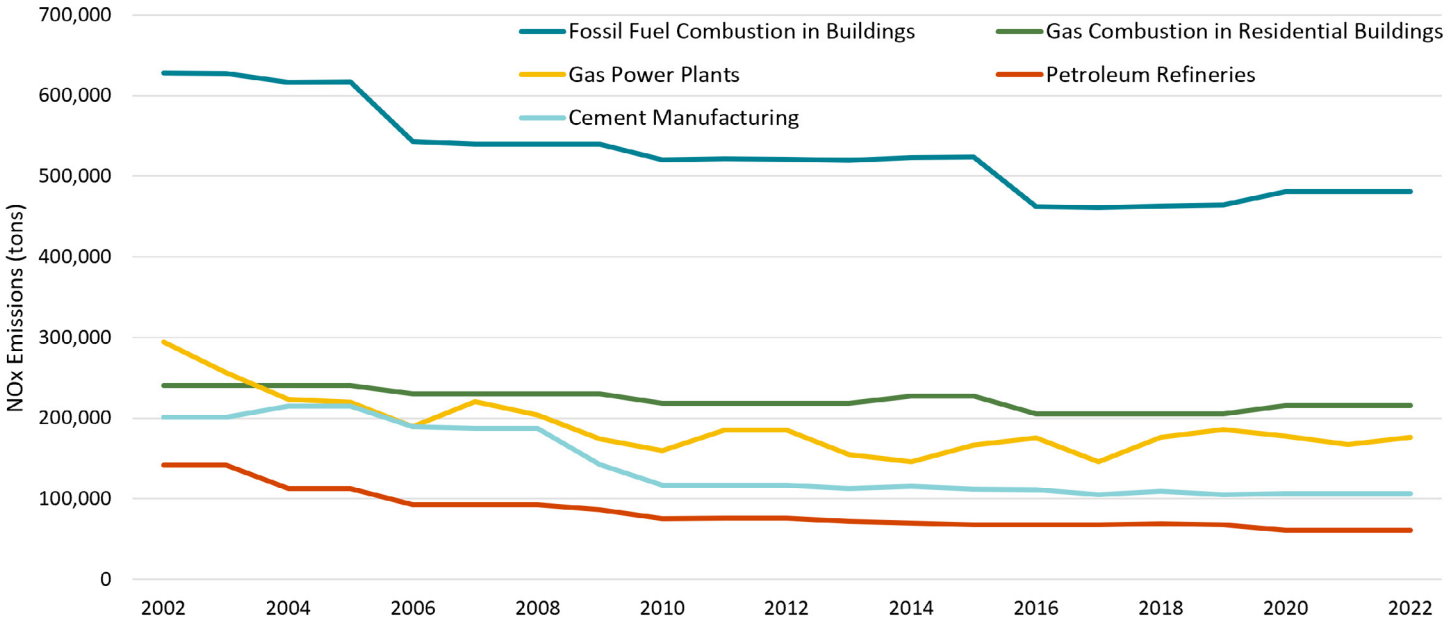
Pollutants

While stoves are not required to be ventilated outdoors and therefore pose **immediate risks to indoor air quality**, fossil fuel burning space and water heating equipment like HVAC systems, furnaces, boilers, and water heaters *are* required to vent directly outdoors and contribute significantly to **outdoor air pollution**.

Burning fossil fuels for space and water heating in our buildings is not only **unnecessary**, it also emits health-harming and climate-disrupting pollution, including (but not limited to) nitrogen oxides (NO_x), carbon monoxide (CO), fine particulate matter ($PM_{2.5}$), and carbon dioxide (CO_2). Together, these pollutants harm all three major organ systems of the body: the respiratory, cardiovascular, and nervous systems.

The Environmental Protection Agency (EPA) tracks national emissions of these four pollutants resulting from fossil fuel combustion in residential and commercial/institutional buildings and publishes the data in the **National Emissions Inventory** and **Inventory of U.S. Greenhouse Gas Emissions and Sinks**. According to the relevant data in these inventories, displayed in Table 1, **pollution across most of these factors increased between 2017 and 2020.**

Figure 1: NO_X Emissions By Sector Over Time - Selected Comparisons



Source: All data from NEI, Downloaded 7/7/2023 from **https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data** *- "National and State EIS Sector CAPs Trends" (April 2023).*

Nitrogen Oxides

Nitrogen oxides (NO_X) are a family of pollutants that form when fuel is burned in the presence of air at high temperatures. This is a process that occurs, among other places, during combustion in space and water heating equipment.

NO_X pollution endangers public health and welfare, both when inhaled directly and when combined with other chemicals to form ground-level ozone (the primary ingredient of smog) and particulate matter (also known as secondary particulate matter). People with asthma, children, and older adults are at increased risk for NO_X-related health effects.

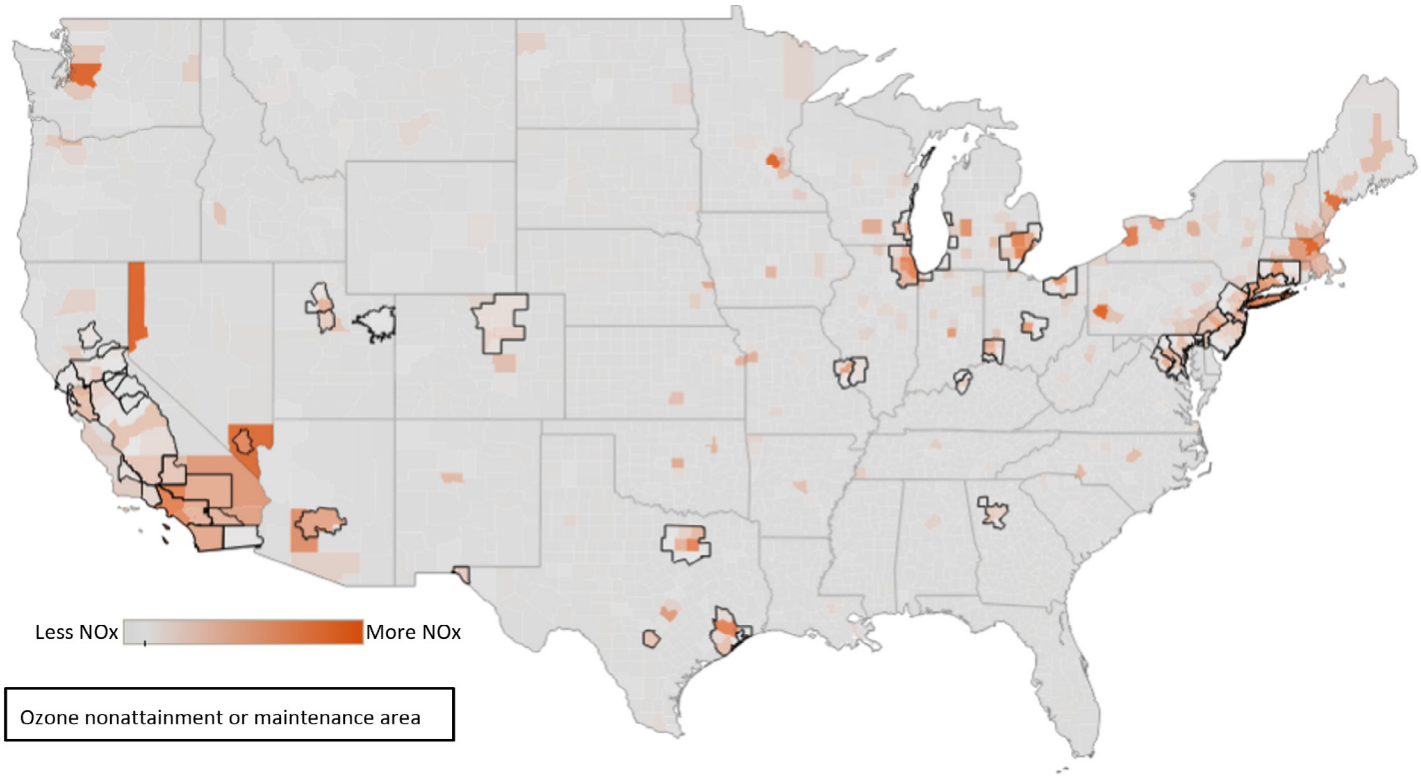
Short-term exposure to nitrogen dioxide (NO_2)[1] reduces lung function to negatively impact the human respiratory system and likely contributes to cardiovascular effects, Sudden Infant Death Syndrome and total mortality. Long-term NO_2 exposure has also been found to result in negative respiratory effects including upper respiratory infections and chronic obstructive pulmonary disease (COPD) exacerbation, as well as cardiovascular effects, diabetes, adverse birth outcomes, cancer, and total mortality.

As demonstrated in Figure 1, EPA's data show that fossil fuel heating equipment in buildings (dark blue line) emit more NO_X than several sources of pollution that EPA already regulates.[2] Notably, NO_X pollution from gas combustion in residential buildings (green line) *on its own* is higher than gas-fired power plant NO_X pollution (yellow line). Not only that; while emissions from other sectors have been slowly declining for over a decade, emissions from fossil fuel combustion in buildings have remained stagnant — and have even begun increasing again in recent years.

1. Data on these emissions and their health effects occasionally refer to nitrogen dioxide (NO_2) more specifically. NO_2 is one of a group of gases called nitrogen oxides, also referred to as "NO_X." While all of these gases are harmful to human health and the environment, NO_2 is sometimes used as the indicator for the various gaseous oxides of nitrogen.

2. EPA has repeatedly recognized the dangers of NO_X pollution and has regulated the pollutant for other sources, including fossil fuel-fired steam generators (40 C.F.R. § 60.44), municipal waste combustors (40 C.F.R. § 60.55a), nitric acid plants (40 C.F.R. § 60.72), stationary gas turbines (40 CFR§ 60.332), and Portland cement plants (40 C.F.R. § 60.62(a)(3), among others.

Figure 2: NO_x Pollution From Fossil Fuel Combustion in Buildings and Ozone Nonattainment/Maintenance Areas



Map Source: **NEI 2020 Supporting Data and Summaries; EPA Green Book GIS Download 8-Hour Ozone (2015 Standard).**

Note: Fossil Fuel Combustion in Buildings includes NO_x emissions for fuel combustion from commercial/institutional and residential coal, gas, oil, and other.

Precursor Pollution: Ozone & Smog

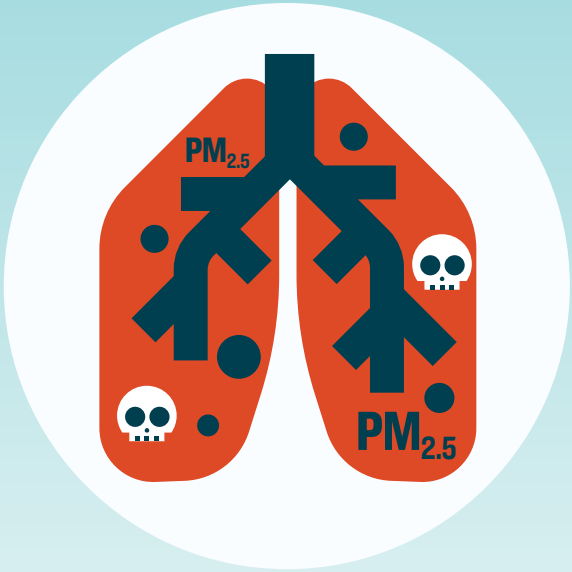
Fossil fuel-burning equipment in buildings emits high levels of NO_x. After being emitted into the atmosphere, NO_x reacts with other pollutants, namely, volatile organic compounds (VOCs), in the presence of heat and sunlight to form **ground-level ozone**,[3] the primary ingredient of smog.

Short-term exposure to ozone can lead to asthma and COPD exacerbation, hospital admissions, and Emergency Department (ED) visits. It is estimated that **up to 11%** of all emergency room visits for asthma in the United States are attributable to ozone exposure. Long-term ozone exposure has been associated with the development of asthma in children.

Figure 2 shows a comparison of 2020 county-level NO_x pollution from buildings and 2022 8-hour Ozone **National Ambient Air Quality Standards** (NAAQS) nonattainment and maintenance areas. This comparison reveals that many of the areas with the highest NO_x pollution from buildings are in ozone nonattainment areas. Four of the top five and 18 of the top 25 counties for appliance NO_x pollution are in ozone nonattainment areas. **Further analysis by RMI** found that in counties in ozone nonattainment areas, average NO_x pollution from buildings exceeds average NO_x pollution from power plants. And in counties in nonattainment areas classified as moderate or higher, buildings emit over twice as much NO_x as power plants on average.

3. Harmful ground-level ozone should not be confused with stratospheric ozone (aka, the "ozone layer"), which forms naturally in the upper atmosphere and protects us from the sun's harmful ultraviolet rays.

$PM_{2.5}$ can lodge deep within the lungs when inhaled and enter the bloodstream, causing serious health impacts **ranging from respiratory and cardiovascular effects to cancer and mortality.**



Particulate Matter

Particulate matter (PM) is the generic term for a broad class of substances that exist as discrete particles. These particles may be emitted directly from a variety of sources, including fossil fuel combustion, or may be formed in the atmosphere by reactions among a variety of pollutants, including NO_x.

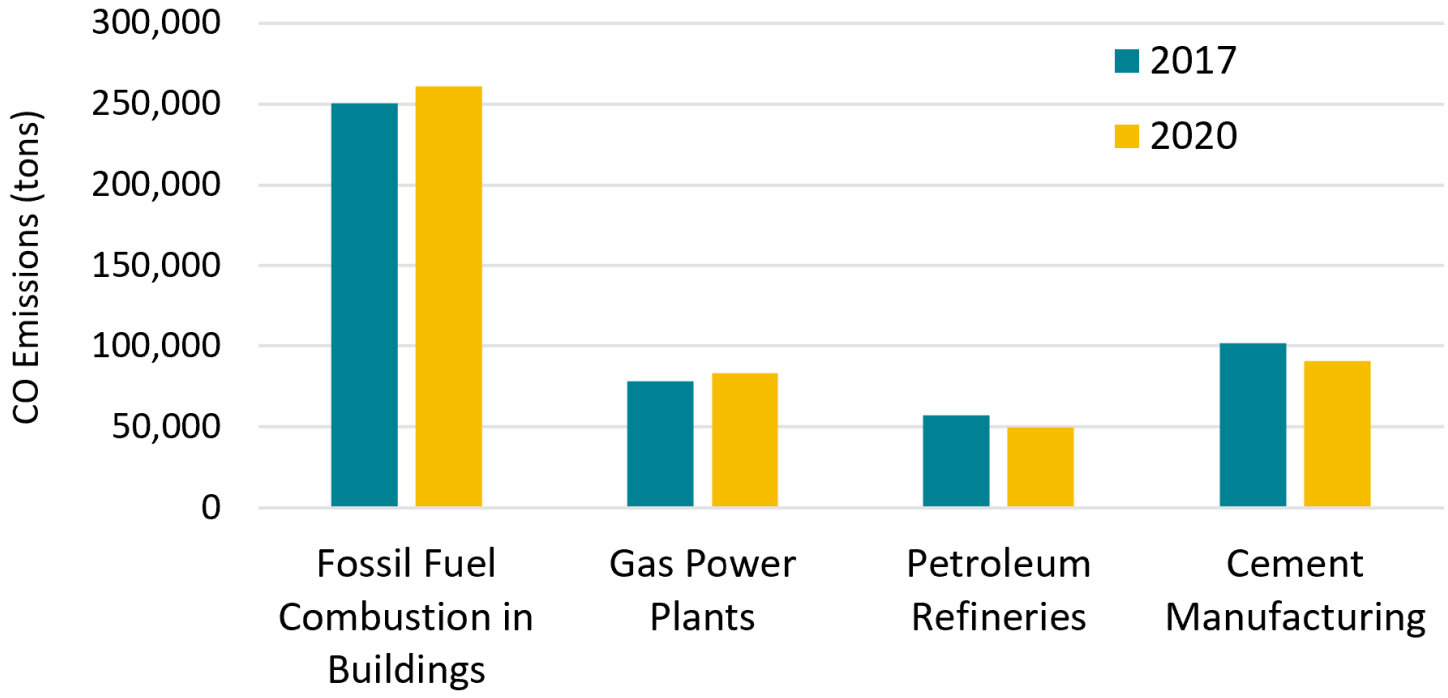
According to EPA's data, fossil fuel combustion equipment in buildings in 2020 emitted 13,895 tons of primary $PM_{2.5}$ (i.e. fine particulates that measure 2.5 micrometers or less in diameter) — 6,058 tons from residential buildings and 7,837 tons from commercial buildings. Similar to the findings around NO_x, many of the areas where buildings make their greatest contributions to ambient $PM_{2.5}$ concentrations (primary and secondary) are in $PM_{2.5}$ nonattainment areas.

EPA and the scientific community agree that there is no safe level of PM exposure.

$PM_{2.5}$ can lodge deep within the lungs when inhaled. The very smallest particles pass through the lungs and enter the bloodstream, causing serious health impacts throughout the body, ranging from respiratory and cardiovascular effects to cancer and mortality. A recent study indicates that the adverse health impacts of $PM_{2.5}$ increase during extreme heat episodes, which are now occurring with increasing frequency due to climate change.

Many populations are at increased risk of a PM-related health effects, including: children, people of color, individuals with pre-existing cardiovascular and respiratory disease, those who are overweight or obese, current or former smokers, and low-income communities. Communities of color are also disproportionately exposed to PM pollution, including from residential gas combustion.

Figure 3: CO Emissions in 2017 and 2020 - Selected Comparisons



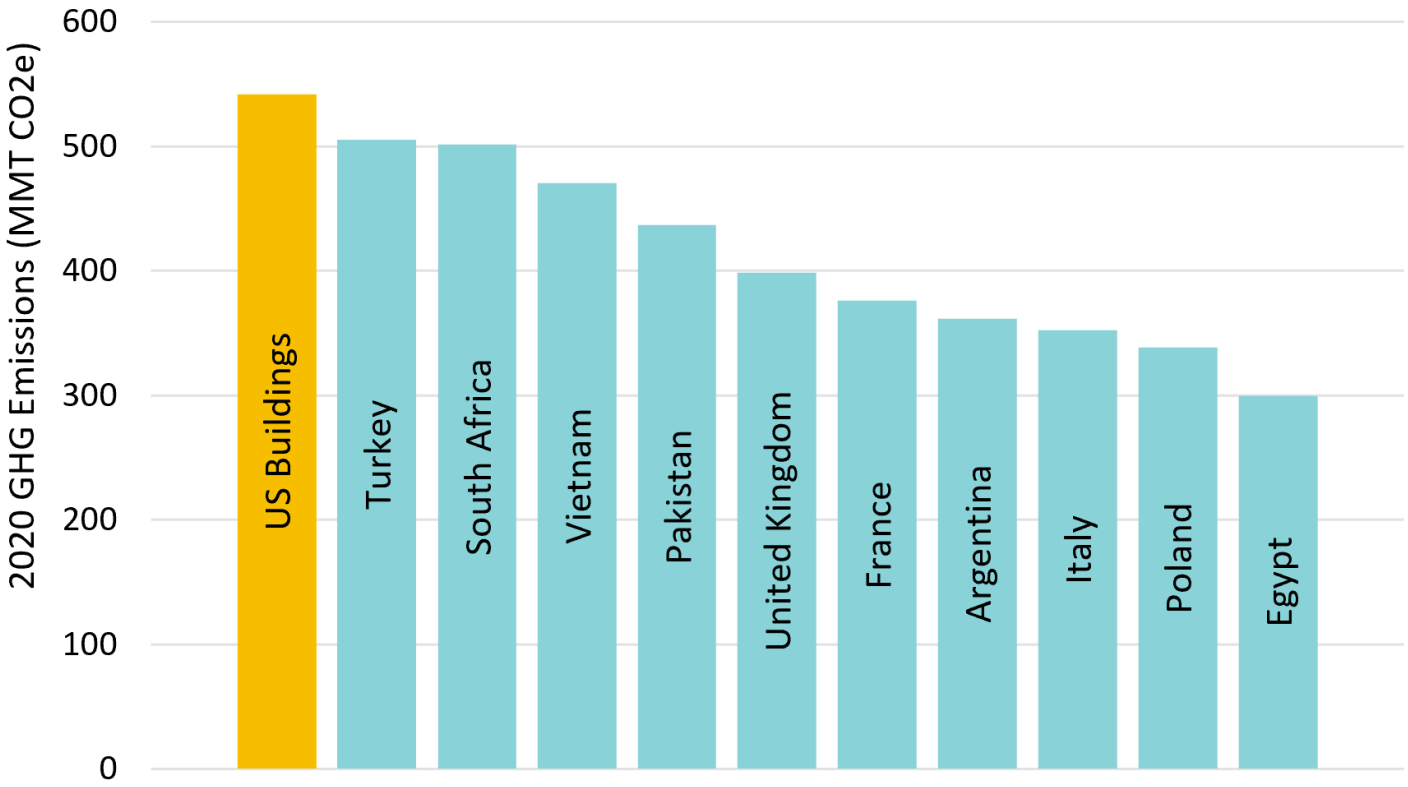
Graph notes: NEI, Downloaded 7/7/2023 from **https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data** *- "National and State EIS Sector CAPs Trends" (April 2023)*

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas that is released when carbon-containing fuels are burned. CO can be extremely harmful to human health when inhaled in large amounts, as it displaces oxygen in the blood and deprives the heart, brain, and other vital organs of oxygen, causing **dizziness, nausea, confusion, tissue damage, and even death**. When we burn fossil fuels in our homes and buildings, we risk lethal exposure to CO; however, even non lethal amounts of exposure are harmful to human health. Even apart from its oxygen deprivation effects, CO exposure **can damage the heart muscle**, leaving cardiac weakness that persists after the toxic gas has been eliminated from the blood.

According to the NEI, fossil fuel combustion in residential and commercial buildings resulted in approximately 260,000 tons of CO pollution into the atmosphere in 2020. This is a slight increase from 2017, when the same categories were responsible for about 250,000 tons of CO pollution. As demonstrated in Figure 3, this is also about triple the amount of CO emitted by cement manufacturing or gas power plants and over five times more CO than petroleum refineries, a source that is already subject to CO regulations under the Clean Air Act. In short, fossil fuel combustion in buildings is a significant source of harmful CO pollution.

Figure 4: GHG Emissions from US Buildings Compared to All-Sector Emissions from Other Countries



Graph Notes:

US Buildings Emissions Source: "CO_2 from fossil fuel combustion", Table 2-10 EPA GHG Inventory 1990-2021
https://www.epa.gov/system/files/documents/2023-04/US-GHG-Inventory-2023-Main-Text.pdf

Other Countries Emissions Source: Climate Watch, All GHG, Total excluding LUCF,
https://www.climatewatchdata.org/ghg-emissions?end_year=2020&sectors=total-excluding-lucf&start_year=1990, *downloaded 7/12/2023*

Carbon Dioxide and Greenhouse Gases

Fossil fuel combustion in buildings in the United States is responsible for **9% of our total greenhouse gas** pollution. Yet, unlike the other primary sectors responsible for climate disrupting pollution, pollution from buildings is almost entirely unregulated.

EPA's **2023 Inventory of Greenhouse Gas Emissions and Sinks** shows that fossil fuel combustion in residential and commercial buildings accounted for 5.2% (313 MMT) and 3.8% (229 MMT) of total CO_2 equivalent pollution in 2020. Together, these figures amount to 542 million metric tons of CO_2 pollution–and the vast majority of that pollution results from fossil fuel-fired heating equipment.

As shown in Figure 4 above, direct pollution from *just* the buildings sector in the United States **exceeded the all-sector GHG pollution of 179 countries** in 2020, including the United Kingdom, France, Italy, South Africa, Vietnam, Egypt, Pakistan, Turkey, Argentina, and Poland.

Table 2: Summary of Health Impacts from Exposure to NO_X, CO, and $PM_{2.5}$

Pollutant	Health Impacts	
	Short-Term Exposure	**Long-Term Exposure**
Nitrogen Oxides (NO_X)	Decreased lung function, asthma exacerbation, respiratory infection, stroke	Premature mortality, cancer, cough, shortness of breath, asthma, wheezing, respiratory illness in children
Carbon Monoxide (CO)	Death, brain damage, seizures, memory loss, dementia, headaches, dizziness, nausea	Brain and heart toxicity, heart failure and cardiovascular disease, low birth weight, and death
Particulate Matter ($PM_{2.5}$)	Stroke, increased blood pressure, and death	Cancer, asthma and bronchitis in children, damages to respiratory system, headaches, sleep disorders, memory loss, birth defects, and death

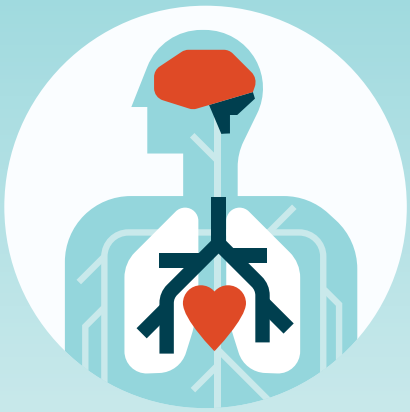
Chart Notes: Health impacts are summarized from EPA's most recent Integrated Science Assessments for each pollutant. The effects of exposure are dependent on dosage as well as duration of exposure.

Health Impacts Summarized

Humans spend 90% of our time in and around buildings. The pollutants emitted into outdoor air as a result of fossil fuel combustion in buildings impact everyone.

Table 2 summarizes the findings of the EPA's **Integrated Science Assessments** for the negative health effects of exposure to NO_X, CO, and $PM_{2.5}$. While respiratory system impacts – ranging from short-term decreased lung function to chronic asthma and bronchitis – are the most common, exposure to these pollutants harms all three of the body's major organ systems: the respiratory, cardiovascular, and nervous systems.

Further analysis in recent years has shown the specific impacts of building pollution on human health. **Harvard public health researchers** found that fossil fuel-fired heating equipment contributions to outdoor $PM_{2.5}$ alone caused roughly 6,000 premature deaths nationwide in 2017 – more than eight times as many deaths as were caused by gas-burning power plants. Using EPA's Benefits Mapping and Analysis Program, **RMI similarly found** that the annual health impacts of fossil fuel appliance pollution include "up to 5,400 premature deaths, 2,300 heart attacks, 55,000 asthma attacks, 2,600 asthma-related emergency room visits, 1,140 hospital admissions, and 355,000 work loss days." The monetized costs of this pollution include $45.8 billion in health costs (in 2017 dollars) and $24.7 billion in climate costs, totaling over $70 billion in social costs in 2017 alone.



While respiratory system impacts – ranging from short-term decreased lung function to chronic asthma and bronchitis – are the most common, exposure to these pollutants **impacts all three of the body's major systems in various ways.**

Disproportionate Impacts

While the harms caused by building pollution are felt broadly across communities, there are disproportionate impacts on environmental justice communities and vulnerable demographic groups.

CHILDREN

Children are **more susceptible** to negative health impacts resulting from pollution exposure for three primary reasons: their respiratory and immune systems are immature, they have higher lung surface to body weight ratios, and they have higher breathing rates and greater levels of physical activity. Children are especially susceptible to NO_2. Research has repeatedly found that combustion-related NO_2 pollution continues to be an important **contributor to the development of asthma in children**, especially in cities where exposure to multiple sources of pollution at once is common. Asthma disproportionately affects Black children, with a **study** finding a non-Hispanic Black child is nearly eight times more likely to die from an asthma attack compared to a non-Hispanic white child.

LOW-INCOME COMMUNITIES

Residents of low-income communities experience **increased health impacts from outdoor air pollution** due to many environmental, social, and economic factors. This is compounded by the additional indoor air pollution and health risks low-income communities face, as housing is closely linked to socioeconomic status. Smaller unit size, higher occupant density, and inadequate ventilation can contribute to **elevated concentrations of pollutants** in lower-income buildings. **Older buildings** are more likely to have inefficient and poorly maintained appliances and ventilation, resulting in increased exposure to air pollution. Low-income communities are also more likely to have to deal with mold, **lead**, pests, and other toxins as well as inadequately heated homes – all conditions that **negatively impact air quality**. Inadequate health and safety conditions are often **barriers to accessing weatherization programs**, creating a feedback loop and trapping low-income residents in unsafe, unhealthy, and inefficient housing.

COMMUNITIES OF COLOR

In the United States, **communities of color are exposed to higher levels of pollution** regardless of region or income level. Black Americans in particular are exposed to higher levels of pollution even though they **produce proportionally less air pollution** than white Americans. Communities of color are also more likely to suffer from preexisting medical conditions that **make them more susceptible** to the detrimental health impacts of pollution. These disparities are **connected to a history of racist policies** in housing, highway construction, and industrial zoning, with the highest levels of pollution generally – and **building pollution specifically** – in many states and cities occurring in areas that were **historically redlined** under the Home Owners' Loan Corporation's (HOLC's) grading system.

Communities of color often deal with substandard housing conditions, disrepair, inefficient appliances, and **high energy burdens**. These realities are compounded by over-polluted neighborhoods and **persistent disinvestment in their communities**, resulting in **worse air quality and poorer health outcomes**.

A recent study showed that communities of color are **exposed to twice as much outdoor $PM_{2.5}$ pollution** from residential gas combustion as white communities. This was the highest relative racial-ethnic disparity in pollution exposure for any of the 14 source categories studied, including power plants, vehicles, and industrial sources. Further **analysis** similarly found that communities of color are substantially more likely to live in census tracts with higher rates of exposure to $PM_{2.5}$ from residential appliances, while the opposite is true for white communities. Additionally, Black people are 55% more likely to die from causes related to appliance pollution than white people.

Asthma is a serious public health concern that disproportionately impacts communities of color. **A report from the Asthma and Allergy Foundation of America** showed that Black, Hispanic, and Indigenous populations have the highest rates of asthma in the United States, and that Black Americans are three times more likely than the general population to die from asthma.

RENTERS

Tenants renting apartments on the unregulated private market are particularly vulnerable to instability, displacement, and unsafe environmental conditions. Renters generally have very little control over which appliances are installed in their homes and **can be difficult to reach** with policies and programs intended to support home health, safety, and energy upgrades. A **majority of renters** live in multifamily buildings, with 46% of rental households residing in buildings of five or more units. Larger buildings often utilize fossil fuel burning boilers in the lower levels or basements for building-wide heating, which **exposes tenants on lower levels to increased pollution**.

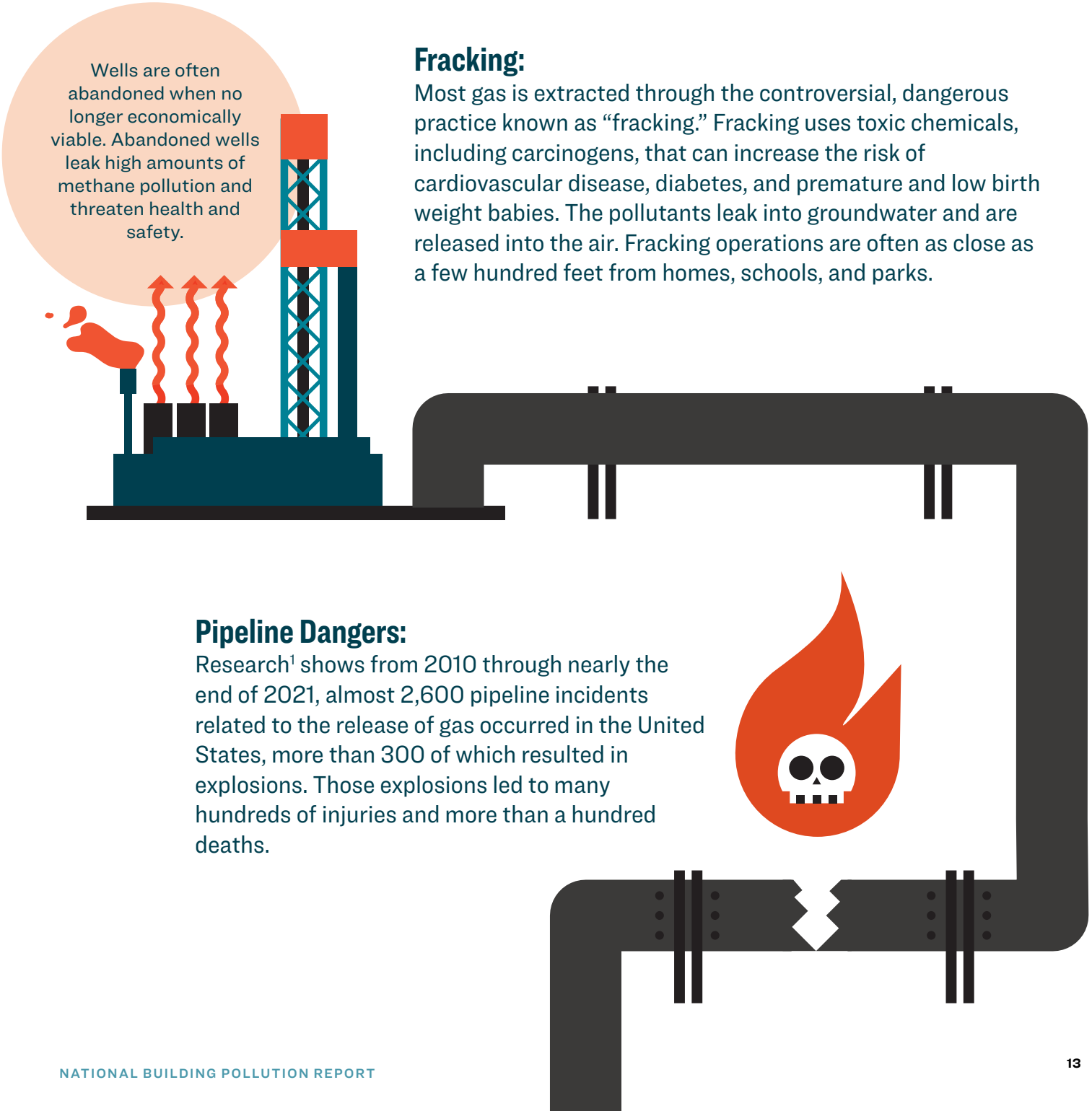
ELDERLY

As people age, their bodies are less able to compensate for the effects of environmental hazards. Older people are also more likely to have pre-existing medical conditions that **make them susceptible** to the impacts of pollution exposure. While ozone and $PM_{2.5}$ have the **greatest potential** to affect the health of older adults, recent research has shown that chronic exposure to elevated NO_2 concentrations as low as 20-40 parts per billion (ppb) can **increase mortality risk** among the Medicare population (65+) by up to 3 percent.

CLIMATE CHANGE

The **health and welfare impacts of climate change** are beyond the scope of this report, but the **disproportionate impacts** bear repeating. **Heat** is the most direct health threat from climate change, **particularly** for older adults and young children, outdoor workers, low-income communities, communities of color, and people with chronic illnesses. Environmental justice communities like those discussed above are also more likely to live in **wildfire** and **flood** prone areas and are at increased risk of **climate gentrification and displacement**. Low-income communities and communities of color also face barriers to accessing disaster assistance funding, which **limits recovery outcomes** when they are impacted by climate change and related weather events.

METHANE — the primary component of gas — has 80 times the warming power of carbon dioxide over a 20-year period. Methane is prone to leaks and is also highly flammable. Hooking a home or building up to the gas system is just one step in the process. Climate-warming pollution and health and safety risks occur at every step of the cycle of gas: from fracking and processing, to waste and transport, to end use.

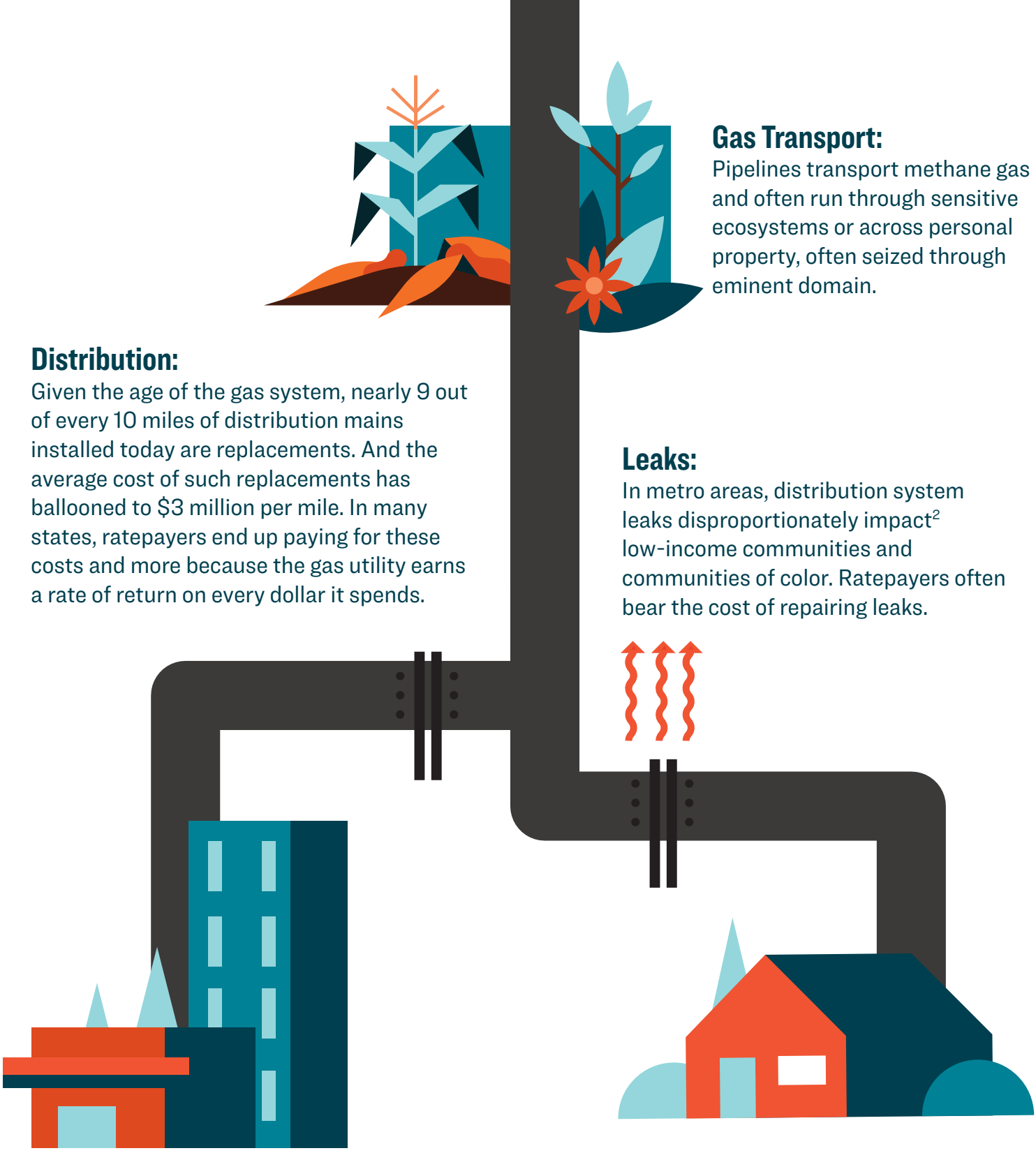


Fracking:

Most gas is extracted through the controversial, dangerous practice known as "fracking." Fracking uses toxic chemicals, including carcinogens, that can increase the risk of cardiovascular disease, diabetes, and premature and low birth weight babies. The pollutants leak into groundwater and are released into the air. Fracking operations are often as close as a few hundred feet from homes, schools, and parks.

Pipeline Dangers:

Research[1] shows from 2010 through nearly the end of 2021, almost 2,600 pipeline incidents related to the release of gas occurred in the United States, more than 300 of which resulted in explosions. Those explosions led to many hundreds of injuries and more than a hundred deaths.



Gas Transport:

Pipelines transport methane gas and often run through sensitive ecosystems or across personal property, often seized through eminent domain.

Distribution:

Given the age of the gas system, nearly 9 out of every 10 miles of distribution mains installed today are replacements. And the average cost of such replacements has ballooned to $3 million per mile. In many states, ratepayers end up paying for these costs and more because the gas utility earns a rate of return on every dollar it spends.

Leaks:

In metro areas, distribution system leaks disproportionately impact[2] low-income communities and communities of color. Ratepayers often bear the cost of repairing leaks.

End Use Hazards:

In 2017 across buildings, power plants, and the industrial sector, burning gas was responsible for nearly $130 billion in health costs and over 11,000 premature deaths.

Pollution from Homes:

Not only does gas combustion in homes and buildings emit health-harming and climate-disrupting pollution, but equipment like water heaters and furnaces leak even when they are not in use.

1 *https://pirg.org/resources/methane-gas-leaks-2/*
2 *https://pubs.acs.org/doi/10.1021/acs.est.2c00097*

Conclusion

THE PROBLEM

The need to decrease air pollution from all economic sectors has never been more urgent. A growing body of research on the devastating health impacts of air pollution, as well as **increasingly frequent climate disasters**, confirm that the United States must dramatically reduce – and, before long, end— the combustion of fossil fuels across the entire economy. Though it is necessary to note that low income communities and communities of color bear a disproportionate burden of air pollution and have the least resources and agency to transition away from burning fossil fuels in their homes.

Fossil fuel-burning space and water heating equipment in our homes and businesses are an overlooked source of air pollution that harms public health and contributes to the climate crisis.

Unlike other sectors, there are no substantive federal regulations on fossil fuel pollution from residential and commercial buildings, even though direct emissions from this sector now account for about **9% of the nation's greenhouse gas (GHG)** pollution and significant amounts of public health harming pollution.

THE SOLUTION

Luckily for us, zero-pollution heating technology exists so that we no longer have to burn fossil fuels in our homes and buildings. **Heat pumps** are an all-electric solution for space and water heating that emit zero direct pollution. Heat pump space heaters can be used for both heating *and* cooling, making them a particularly useful **climate resiliency tool** in regions that are experiencing either extreme heat or extreme cold weather for the first time.

All-electric construction with heat pumps is already the **most cost-effective choice for new buildings** and is becoming increasingly affordable for retrofitting existing homes and buildings – both due to **transforming market conditions** and new funding streams authorized in the **Inflation Reduction Act** (IRA), Infrastructure Investment and Jobs Act, and various state and local incentive programs across the country. However, it is critical to embed equity in any solution to addressing building emissions. As noted earlier, not only do environmental justice communities bear a disproportionate burden of air pollution, they also are in the greatest need of assistance to transition away from the use of fossil fuels in buildings. These initial programs are a great start, but they are not enough to fully realize our climate and public health goals and support an equitable transition.

Menu of Policy Solutions

EPA must use its Clean Air Act authority to regulate harmful pollution from fossil fuel combustion in buildings across the country. State and local governments can also enact policies to improve public health, advance building decarbonization efforts, and reduce our reliance on fossil fuels.

The policies listed below are just a few of the key policy levers that state and local governments can use to tackle pollution from buildings. Complementary strategies like electrification-friendly rate design, training for heat pump installers, and **climate-forward energy efficiency programs** will also be key to success.

STATE AND LOCAL POLICIES

- **Pollution Standards**
  - State governments can implement **zero-pollution standards** for new space and water heating equipment by 2025 that go into effect statewide by 2030. Standards can also be **set regionally** in metro areas with local air agencies.
- **Building Performance Standards**
  - State and local governments can set requirements for existing large buildings over 20,000 square feet to benchmark and improve energy performance to achieve zero direct emissions by 2040.
- **All-Electric Building Ordinances**
  - State and local governments can adopt building energy codes requiring all new construction and major renovations to be all-electric by 2025, and can lead by example by committing to such requirements for **public buildings** first.
- **Gas Infrastructure and Clean Heat Planning**
  - State utility commissions can adopt comprehensive planning rules for gas utilities that reduce greenhouse gas emissions, end ratepayer backed subsidies for gas infrastructure (**such as line extension allowances**), ensure utilities' customer growth forecasts account for trends indicating fewer buildings will be constructed with gas, and allow commission scrutiny of capital investments in the gas distribution system.
- **Targeted Neighborhood Electrification and Gas Decommissioning**
  - States and utilities can implement a pilot or planning process to **target areas for gas infrastructure decommissioning** and neighborhood electrification, with an emphasis on environmental justice and low-income communities.
- **Home Retrofit Programs**
  - State and local governments can establish **whole-home** retrofit programs that combine funding streams to address health and safety repairs, energy efficiency and weatherization, electrification, and energy assistance. These programs must have a **focus on low-income households** and environmental justice communities.

FEDERAL ACTION

- **Implement Federal Funding Programs**
  - Existing programs like the **Weatherization Assistance Program** (WAP) and **Low Income Home Energy Assistance Program** (LIHEAP) are critical to support low-income communities and address **energy burden**; however, these programs are chronically under-resourced and fail to reach all eligible households. Implementation support for these programs is necessary to improve the health, safety, and affordability of all low-income homes across the country.
  - New programs like the **Home Energy Rebates** and **Clean Energy Tax Credits** funded through the Inflation Reduction Act are an important step forward, but these programs have end dates and are not large enough to meet the need for home retrofits. It is necessary to continue funding consumer incentives throughout the clean energy transition.
- **EPA Clean Air Act Pollution Standards**
  - The Environmental Protection Agency has **the authority and obligation to set standards** for sources that significantly contribute to harmful air pollution. Buildings – and more specifically, fossil fuel burning space and water heating equipment used in buildings – contribute significantly to harmful air pollution. Because heat pumps exist as a **zero-pollution alternative**, EPA must set an end date for the use of polluting fossil fuel equipment by the end of the decade.

Selected References

Emissions and Energy Use Data

- EPA, National Emissions Inventory and Air Pollutant Emissions Trends Data
  - » Source of annual national emissions data for nitrogen oxides (NO_x), carbon monoxide (CO), and fine particulate matter ($PM_{2.5}$).
- EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks
  - » Source of annual national emissions data for carbon dioxide (CO_2)
  - » Table 2-10: U.S. Greenhouse Gas Emissions Allocated to Economic Sectors
- EIA, Residential Energy Consumption Survey (RECS)
  - » Table HC1.1 Fuels used and end uses in U.S. homes, by housing unit type, 2020
  - » Table HC6.1 Space heating in U.S. homes, by housing unit type, 2020

EPA Criteria Pollutants: NO_x, Ozone, $PM_{2.5}$, and CO

- Nitrogen Dioxide (NO_2) Pollution
- Ground-level Ozone Pollution
- Particulate Matter (PM) Pollution
- Carbon Monoxide (CO) Pollution in Outdoor Air

Health Impacts: EPA's Integrated Science Assessment (ISA)

- Oxides of Nitrogen - Health Criteria, 2016
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Research Studies

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Sierra Club Resources

- Avoid False Solutions for Clean and Healthy Buildings, 2023
- Keep Calm, But Don't Ignore the Warnings About Gas Stoves, 2023
- Understanding the IRA Home Energy Rebate Programs, 2023
- Heat Pump 101: The Lowdown on the Hottest (And Coolest) Appliance You've Never Heard Of, 2022
- Energy Burden Calculator

Complementary Resources

ACEEE, Energy Equity for Renters Toolkit

ACEEE, Climate-Forward Efficiency Initiative

Asthma and Allergy Foundation of America, Asthma Disparities in America: A Roadmap to Reducing Burden on Racial and Ethnic Minorities, 2020

EIA, 2020 Residential Energy Consumption Survey (RECS) Interactive Dashboard

EPA, Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts, 2021

Green & Healthy Homes Initiative, Leading with Equity and Justice in the Clean Energy Transition: Getting to the Starting Line for Residential Building Electrification, 2021

PIRG, Methane Gas Leaks: Frequent leaks are resulting in death, injury and other damage to our health and environment, 2022

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WE ACT for Environmental Justice, Out of Gas, In With Justice Report, 2023