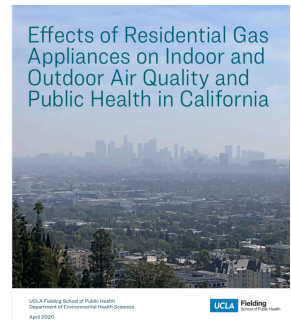


EXECUTIVE SUMMARY

Health-threatening Air Pollution Emitted from Household Gas Appliances Dr. Yifang Zhu, P.I. et al, UCLA, April 2020

The electrification of residential buildings refers to the transition from fossil-fuel-powered appliances to electric technologies. Dozens of cities in California have already passed electrification policies to ensure new constructions within their jurisdictions are built all-electric. State regulatory agencies and utilities are pursuing programs and policies to support residential and commercial building electrification as part of meeting the state's climate and energy goals.



There has been considerable focus on building electrification's potential to reduce greenhouse gas emissions, and less focus on how electrification can also yield significant air quality and public health benefits.

California currently faces a global pandemic in which a rapidly spreading coronavirus disease, COVID-19, can cause severe respiratory illness and even death. New evidence suggests that a small increase in long-term exposure to fine particulate matter (PM_{2.5}) leads to a large increase in the COVID-19 death rate; this further establishes the substantial value in protecting the population from the respiratory vulnerability caused by widespread air pollution.

Exposure to the pollutants produced from gas appliances can be detrimental to human health; thus, one significant benefit of replacing natural gas (hereafter referred to as "gas") appliances with electric appliances would be the elimination of indoor air pollution that comes from burning gas indoors. This report aims to better understand the health concerns associated with gas appliance use, as well as the health benefits of phasing out residential gas appliances in California.

To systematically evaluate the impact of gas appliances on indoor air quality (Section 2), we developed an emission factor (EF) database, provided an estimate of indoor air pollutant concentrations due to gas appliance usage, and characterized the associated health impacts .

Next, we evaluated the potential health co-benefits resulting from changes to ambient (outdoor) air quality related to residential gas appliance electrification (Section 3) . This was accomplished by estimating the total emission of outdoor air pollutants in California due to the use of household gas appliances, the reduction in emissions due to residential building electrification under a modeled transition scenario, the resulting reduction of premature deaths and cases of acute and chronic bronchitis in California, and monetization of those health benefits. A detailed description of the data and methods can be found in Appendix A.

Key Findings

INDOOR AIR QUALITY

- Gas appliances emit a wide range of air pollutants, such as carbon monoxide (CO), nitrogen oxides (NO_x, including nitrogen dioxide (NO₂)), particulate matter (PM), and formaldehyde, which have been linked to various acute and chronic health effects, including respiratory illness, cardiovascular disease, and premature death.
- Under a hypothetical cooking scenario where a stove and oven are used simultaneously for 1 hour, peak concentrations of NO₂ from cooking with gas appliances exceed the levels of acute national and California-based ambient air quality thresholds in more than 90% of modeled emission scenarios.

- Concentrations of CO and NO₂ resulting from gas cooking are the highest for apartments, due to a smaller residence size. This presents an additional risk for renters, who are often low-income.
- Increases in indoor air pollutant concentrations can be driven by insufficient ventilation. Surveys show that less than 35% of California residents use range hoods when cooking — and many homes in the U.S. are lacking range hoods or ventilation altogether.
- The use of kitchen appliances for supplemental heating can increase exposure risks, and there is evidence this disproportionately affects low-income households, though more data on the frequency of use is needed to quantify the risk to various populations.
- Environmental justice communities disproportionately experience poor housing conditions which can be detrimental to health. Concerns related to gas appliance use include: the presence of old and unmaintained appliances in households, smaller and overcrowded residences where air pollution can reach higher concentrations, and challenges faced by renters to control appliance choices or afford maintenance. These populations already face cumulative effects associated with health and environmental injustices more broadly, and gas appliance issues can compound this. There are significant data gaps regarding equity and the health effects of gas combustion on low-income and minority populations, which should be further explored to facilitate a just transition to a low-carbon future.
- Better regulations and safeguards are needed to protect residents from exposure to indoor air pollution from gas appliances. Along with replacing gas kitchen appliances with electric alternatives, increasing the frequency of range hood use and improving the efficacy of

ventilation technology would also reduce exposure and protect public health.

OUTDOOR AIR QUALITY

- Gas appliances are also a source of outdoor air pollution, and literature shows that the pollutants released by combustion can lead to illness and premature death.
- Using the EFs developed in this study's indoor air quality analysis, and assuming all indoor emissions are transported to the outdoor environment, we find that approximately 12,000 tons of CO and 15,900 tons of NO_x (see Figure 3-1 in Section 3.2.1) were emitted to outdoor air from the use of residential gas appliances in California in 2018.
- If all residential gas appliances were immediately replaced with clean electric alternatives, the reduction of outdoor NO_x and PM_{2.5} would result in 354 fewer deaths, as well as 596 fewer cases of acute bronchitis and 304 fewer cases of chronic bronchitis annually in California (Table 3-1). This is equivalent to approximately \$3.5 billion in monetized health benefits over the course of one year. These numbers only account for exposures from outdoor air as a result of residential electrification; a full exposure assessment accounting for indoor exposures would increase the total health benefits and the associated economic benefits of residential electrification.

In summary, this report contributes to a growing body of research quantifying the air quality and health impacts from the use of gas appliances in households, and highlights several potential benefits, both health-related and economic, of residential electrification throughout the state of California. While this report provides an estimate of emissions, and resulting emission reductions from discontinuing the use of gas appliances in residences, it does not consider the full spectrum of costs and benefits associated with residential building electrification. Policymakers and stakeholders are encouraged to use this report, alongside existing research on building decarbonization, electrification, and other related topics, as a tool to develop stronger regulations and protections that limit indoor and outdoor air pollution from gas appliances, and to support new policy development to improve public health, particularly for communities disproportionately burdened by pollution from fossil fuels.

