Case No. 21-16278

IN THE UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

CALIFORNIA RESTAURANT ASSOCIATION,

Plaintiff-Appellant,

v.

CITY OF BERKELEY,

Defendant-Appellee.

On Appeal from the United States District Court
for the Northern District of California
No. 4:19-cv-07668-YGR

BRIEF OF *AMICI CURIAE* CLIMATE HEALTH NOW; SAN FRANCISCO BAY PHYSICIANS FOR SOCIAL RESPONSIBILITY IN SUPPORT OF DEFENDANT-APPELLEE CITY OF BERKELEY AND AFFIRMANCE

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INTERESTS OF THE *AMICI CURIAE*[1]

Amici are organizations comprised of experts in public health and medicine focused on climate change advocacy and bettering climate health. Through their work, the *amici* have advocated against the adverse effects of fossil gas appliance use on indoor and outdoor air quality and its related negative health outcomes. The *amici* support efforts to limit the expansion and continued use of fossil gas uses and applications in buildings in the interests of improving public health, such as the City of Berkeley's ordinance.

Amicus Climate Health Now is a California-based coalition of doctors, nurses, health professionals, and health students, working to bring the California medical community to the larger climate justice movement to advocate for a rapid and just transition off harmful fossil fuels toward a healthy, equitable society sustained by renewable energy.

Amicus San Francisco Bay Physicians for Social Responsibility is a nonprofit education and advocacy organization that mobilizes physicians and health professionals to advocate on issues that threaten communities, leveraging

[1] Pursuant to Federal Rule of Appellate Procedure Rule 29(a)(2), *amici* state that all parties have consented to the filing of this brief. Pursuant to Federal Rule of Appellate Procedure 29(A)(4)(e), *amici* certify that no person or entity, other than *amici* or its counsel, made a monetary contribution to the preparation or submission of this brief or authored this brief in whole or in part.

medical and public health expertise to reverse the trajectory towards global warming and protect public health.

INTRODUCTION AND SUMMARY OF ARGUMENT

Pollution from the burning of fossil fuels has wide-ranging public health impacts that are well-documented in scientific literature and pose unacceptable risks to human health. Fossil fuel combustion in buildings is one of the leading sources of indoor air pollution, and the use of gas-powered appliances produces high levels of harmful indoor emissions that often exceed federal outdoor air quality standards. The consequent air pollution inside homes and buildings has a significant impact on human health and can lead to a range of serious negative health outcomes, including increased asthma risk, higher rates of respiratory and cardiovascular illnesses, and impaired neurodevelopment. These health harms are further exacerbated given that the average person in the United States spends nearly 90 percent of their time indoors.[2]

Partial mitigation of pollution from gas appliances can only be achieved through source ventilation (i.e. exhaust hoods) of these pollutants outside. However, reducing exposure to these indoor pollutants through ventilation is often ineffective because of non-uniform ventilation requirements. Depending on

[2] U.S. Env't Prot. Agency, *The Inside Story: A Guide to Indoor Air Quality*, https://www.epa.gov/indoor-air-quality-iaq/inside-story-guide-indoor-air-quality (last visited Jan. 12, 2022) [hereinafter EPA Indoor Air Quality Guide].

building code requirements, exhaust hoods for gas stoves, for example, may not even be required to vent outdoors.[3] Sporadic usage also contributes to greater accumulation of indoor pollution inside the home. For example, one recent study analyzed a sample of homes in California and found that individuals only use their range ventilation hoods when cooking 28 to 36 percent of the time.[4]

Even if ventilated, emissions of certain criteria air pollutants[5] from gas appliances, such as nitrogen oxides and particulate matter, contribute to outdoor air pollution and worsen ambient air quality.[6] Gas appliances use also results in direct methane emissions—a potent greenhouse gas that has global warming potential that is up to 82.5 times higher than carbon dioxide.[7] Even when not in use, gas appliances have been shown to leak methane in and outside the home, contributing to degraded indoor and outdoor air quality, and accelerating climate change. In

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[3] Brady A. Seals et al., RMI, *Health Effects from Gas Stove Pollution* 16 (2020).
[4] Haoran Zhao et al., *Factors Impacting Range Hood Use in California Houses and Low-Income Apartments*, 17 Int'l J. Env't. Res. Pub. Health 8870 (2020).
[5] Criteria air pollutants are particulate matter, photochemical oxidants (including ozone), carbon monoxide, sulfur oxides, nitrogen oxides, and lead that are subject to National Ambient Air Quality Standards (NAAQS). *See* U.S. Env't Prot. Agency, *Criteria Air Pollutants*, https://www.epa.gov/criteria-air-pollutants (last visited Jan. 31, 2022).
[6] Yifang Zhu et al., UCLA, *Effects of Residential Gas Appliances on Indoor and Outdoor Air Quality and Public Health in California* 45 (2020).
[7] Intergovernmental Panel on Climate Change Working Group I Sixth Assessment Report, Climate Change 2021: The Physical Science Basis 7-125 (2021), https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_07.pdf [hereinafter IPCC Sixth Assessment Report].

fact, a recent study estimates that methane emissions due to gas stoves and water heaters alone is nearly four and a half times more than current U.S. Environmental Protection Agency (EPA) estimates for total residential stationary sources.[8]

Even without considering these substantial methane leaks, fossil fuel combustion attributed to residential and commercial buildings accounts for almost 13 percent of total greenhouse gas emissions in the United States,[9] and 37 percent of emissions in the City of Berkeley.[10] Even more staggering is that gas appliances emit over twice as much nitrogen oxide pollution as gas-fired power plants nationwide, despite burning less gas.[11] The combustion of fossil fuels is the primary driver of global temperature rise, changes in weather patterns, and ecosystem degradation—all of which pose existential threats to human health and the well-being of all people today and in future generations. Measures such as Berkeley's ordinance ending new gas hookups would curb the numerous public health harms from fossil fuel end uses in buildings and are justified to protect the health and wellbeing of citizens of the City.

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[8] Eric D. Lebel et al., *Quantifying Methane Emissions from Natural Gas Water Heaters*, 54 *Env't Sci. & Tech*. 5737 (2020).
[9] U.S. Env't Prot. Agency, *Sources of Greenhouse Gas Emissions: Commercial & Residential Sector Emissions*, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#commercial-and-residential (last visited Feb. 3, 2022).
[10] City of Berkeley, Climate Action Plan and Resilience Update 2 (2020).
[11] Jim Dennison et al., RMI, *How Air Agencies Can Help End Fossil Fuel Pollution from Buildings* 5 (2021), https://rmi.org/insight/outdoor-air-quality-brief/.

For these reasons Climate Health Now ("CHN") and the San Francisco Bay Physicians for Social Responsibility ("SF-Bay PSR") (collectively, "*amici*"), request that the Court deny Plaintiff's appeal, and affirm the ruling of the district court.

ARGUMENT

I. The use of gas appliances causes harmful air pollution inside of buildings

The burning of fossil fuels, including in the use of gas appliances, releases harmful pollution such as nitrogen oxides (NOx, which collectively describes gases including nitric oxide (NO) and nitrogen dioxide (NO_2)), fine particulate matter ($PM_{2.5}$), and carbon monoxide (CO), as well as benzene and formaldehyde.[12] According to EPA, unburned, incompletely burned, and completely burned gas from gas appliances releases harmful chemicals into household air.[13] EPA has acknowledged that nitrogen oxide pollution, which is a precursor pollutant to ground-level ozone and fine particulate matter, is "an inherent consequence of fossil fuel combustion."[14] Carbon monoxide is an odorless, colorless, and toxic gas produced by the incomplete combustion of fuels,[15] and is emitted through the use

[12] Zhu et al., *supra* note 6, at 6.
[13] EPA Indoor Air Quality Guide, *supra* note 2.
[14] U.S. Env't Prot. Agency, *Nitrogen Oxides*, 1-1 (1977), https://nepis.epa.gov/Exe/ZyPDF.cgi/2000XWPA.PDF?Dockey=2000XWPA.PDF (last visited Jan. 24, 2022). *See also* Dennison et al., *supra* note 11, at 6.
[15] Seals et al., *supra* note 3, at 9.

of gas stoves, gas water heaters, and gas furnaces. Particulate matter is a term used for a mixture of solid particles and liquid droplets found in the air.[16] $PM_{2.5}$, or fine particulate matter, refers to inhalable particles with diameters that are 2.5 micrometers and smaller.[17] $PM_{2.5}$ is mainly produced by "combustion processes and by atmospheric reactions of various gaseous pollutants."[18] As it relates to cooking, while $PM_{2.5}$ is a byproduct of both electric and gas stoves and ovens, emissions from gas stoves can be two times higher than from electric stoves.[19]

Indoor environments are often more polluted than outdoor environments. EPA states that indoor levels of pollutants may be two to five and as much as 100 times higher than outdoor air pollution levels.[20] The levels of these pollutants released into the home due to gas appliance use are alarming. Gas stoves used without exhaust hoods can expose household occupants to NO_2 levels that exceed health-based standards.[21] The use of gas burners is estimated to add between 25 to

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[16] 62 Fed. Reg. 38,652, 38,653 (July 18, 1997).
[17] *Id.* at 38,654 fn. 6.
[18] 71 Fed. Reg. 61,144, 61,146 (Oct. 17, 2006).
[19] Tianchao Hu et al., Lawrence Berkeley Nat'l Lab'y, *Compilation of Published PM2.5 Emission Rates for Cooking, Candles and Incense for Use in Modeling Exposures in Residences* 11 (2012).
[20] U.S. Env't Prot. Agency, *Why Indoor Air Quality is Important to Schools*, https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools (last visited Feb. 3, 2022).
[21] Seals et al., *supra* note 3, at 7, 21 (citing Jennifer M. Logue et al., *Pollutant Exposures from Natural Gas Cooking Burners: A Simulation-Based Assessment for Southern California*, 122 Env't. Health Perspectives 43 (2014)).

39 percent more nitrogen dioxide emissions and between 21 to 30 percent higher concentrations of carbon monoxide indoors.[22] In 2008, EPA found that "homes with gas cooking appliances have approximately 50 percent to over 400 percent higher average NO_2 concentrations than homes with electric cooking appliances."[23] The short- and long-term NO_2 levels in homes with gas stoves often exceed outdoor EPA air quality standards, which in turn are less stringent than the indoor air quality guidelines issued by the World Health Organization and Health Canada.[24] Currently, the National Ambient Air Quality Standard (NAAQS) for NO_2 is 100 parts per billion (ppb) over a one-hour period. However, recent studies have shown that gas oven operation alone could produce enough peak NO_2 to exceed this one-hour standard within a matter of minutes.[25] These high levels of NO_2 pollution are more likely when gas stoves are operated without the use of exhaust hoods.[26] The concentration of NO_2 in homes is even higher during the winter, when ventilation in homes is lowest, and a study by the Berkeley National

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[22] Wendee Nicole, *Cooking Up Indoor Air Pollution: Emissions from Natural Gas Stoves*, 122 Env't Health Persps. 1 (2014), https://ehp.niehs.nih.gov/doi/10.1289/ehp.122-a27.

[23] U.S. Env't Prot. Agency, *Integrated Science Assessment For Oxides Of Nitrogen – Health Criteria*, 2-38 (2008).

[24] Seals et al., *supra* note 3, at 11. The U.S. EPA has not issued guidelines or standards for indoor air quality.

[25] Eric D. Lebel et al., *Methane and NO Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes*, Env't Sci. & Tech., G (preprint 2022).

[26] *See* Seals et al., *supra* note 3, at 7.

Laboratory found that 51 to 64 percent of homes using gas stoves during winter regularly experienced household NO_2 levels that exceeded health-based outdoor air standards.[27] Similarly, homes with gas stoves have higher levels of carbon monoxide. While the average level of carbon monoxide in homes without gas stoves varies from 0.5 to 5 parts per million (ppm), CO concentrations in homes with properly adjusted gas stoves are often 5 to 15 ppm, and homes with poorly adjusted stoves may have levels 30 ppm or higher.[28] As noted above, research has shown that that California households use their range ventilation hoods infrequently,[29] further exacerbating the concentration of pollutants in the home.

As will be discussed below, the exposure to these substances in the home is harmful to public health. These exposures would be abated by measures curbing gas appliance usage in the home, and the Berkeley Ordinance prohibiting new gas appliance hookups is a reasonable and effective method of curbing the continued emission of these pollutants in and outside of buildings.

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[27] Andee Krasner et al., *Cooking with Gas, Household Air Pollution, and Asthma: Little Recognized Risk for Children*, 83 J. Env't. Health 8, 14 (2021) (citing Jennifer M. Logue et al., *Pollutant Exposures from Natural Gas Cooking Burners: A Simulation-Based Assessment for Southern California*, 122 Env't. Health Persps. 43 (2014)).
[28] EPA Indoor Air Quality Guide, *supra* note 2.
[29] Zhao et al., *supra* note 4.

II. Indoor pollution from continued fossil gas combustion threatens public health

The continued use of gas appliances in buildings has serious public health implications for the general population. Exposure to gas appliance-related pollution, including nitrogen dioxide, $PM_{2.5}$, and carbon monoxide has been linked to negative human health effects, including higher rates of respiratory and cardiovascular illnesses and childhood asthma.[30]

TABLE 1

U.S. Environmental Protection Agency (U.S. EPA) Listed Health Effects of Chemicals Emitted From Burned Natural Gas

Chemical Name	Health Effect
Nitrogen dioxide (U.S. EPA, 2016)	• Contributes to the development of asthma, aggravated asthma, and increases susceptibility to respiratory infections
$PM_{2.5}$ (U.S. EPA, 2020b)	• Aggravates asthma, decreases lung function, and increases respiratory symptoms • Nonfatal heart attacks and irregular heartbeat • Premature death in people with heart or lung disease
Carbon monoxide (U.S. EPA, 2020c)	• Neurological effects including fatigue, impaired vision, reduced brain function, dizziness, confusion, nausea, and coma • Chest pain in people with heart disease • Death
Benzene (U.S. EPA, 2012)	• Neurological effects including drowsiness, dizziness, headaches, and unconsciousness • Aplastic anemia, excessive bleeding, and damage to the immune system • Leukemia
Formaldehyde (U.S. EPA, 2020d)	• Irritation of the skin, eyes, nose, and throat • Cancer

[31]

[30] Seals et al., *supra* note 3, at 12-13; Krasner et al., *supra* note 27, at 14.
[31] Krasner et al., *supra* note 27, at 15, Table 1.

Nitrogen dioxide is the component of NO_x that is of greatest concern for health and is known to cause asthma-related health effects.[32] In 1971, EPA established the first national ambient air quality standard for NO_2 in recognition of the harmful health effects of NO_2 exposure.[33] EPA has acknowledged that even short-term NO_2 exposure can cause respiratory health effects, such as impaired lung function, respiratory symptoms, inflammation of the airway, and asthma exacerbations requiring hospitalization.[34] NO_2 exposure has also been linked to chronic obstructive pulmonary disease,[35] and research suggests a link between elevated NO_2 levels and cardiovascular effects, diabetes, cancer, and reproductive harms.[36]

Carbon monoxide exposure is associated with poisoning and deleterious cardiovascular effects. CO poisoning results in 430 deaths and approximately 50,000 emergency department visits in the United States annually.[37] Since 2000, 13

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[32] U.S. Env't Prot. Agency, *Fact Sheet: Review of the Primary National Ambient Air Quality Standards for Oxides of Nitrogen*, https://www.epa.gov/sites/default/files/2018-04/documents/no2_naaqs.final_action.fact_sheet_4.6.18.pdf (last visited Feb. 4, 2022).
[33] 36 Fed. Reg. 8186 (Apr. 30, 1971).
[34] 75 Fed. Reg. 6474, 6479-80 (Feb. 9, 2010).
[35] Seals et al., *supra* note 3, at 12; U.S. Env't Prot. Agency, *Integrated Science Assessment (ISA) For Oxides of Nitrogen – Health Criteria*, 1-17, 5-55 (2016)) [hereinafter 2016 NOx ISA].
[36] *Id.*
[37] Ctrs. for Disease Control & Prevention, *Carbon Monoxide Poisoning (CO)*, https://www.cdc.gov/dotw/carbonmonoxide/index.html (last visited Feb. 4, 2022).

to 36 individuals die each year from non-fire-related CO poisoning in California.[38] The effects of CO exposure on human health have been documented for over a decade. In 2010, EPA stated that there is likely a causal relationship between short-term CO exposure and cardiovascular morbidity and mortality, such as heart attack, congestive heart failure, and ischemic heart disease.[39] Individuals with coronary heart disease are vulnerable to experiencing adverse health effects from even low levels of CO exposure and are more likely to have a higher number of hospital admissions from CO exposure.[40] CO exposure is also linked to respiratory and cardiovascular illnesses and neurological impairment.[41]

Exposure to $PM_{2.5}$ pollution has significant adverse effects on human health. Elevated $PM_{2.5}$ levels have been linked to premature mortality; heart attacks, strokes, worsening of chronic heart failure, and sudden cardiac death; impaired fetal and childhood lung function development; acute and chronic decreases in lung function; respiratory infections; respiratory emergency department visits,

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[38] Cal. Air Res. Bd., *Carbon Monoxide and Health,* https://ww2.arb.ca.gov/resources/carbon-monoxide-and-health (last visited Feb. 4, 2022).
[39] U.S. Env't Prot. Agency, *Integrated Science Assessment for Carbon Monoxide (CO)*, 2-5–2-6 (2010), https://www.epa.gov/isa/integrated-science-assessment-isa-carbon-monoxide.
[40] *Id.* at 2-10.
[41] *Id.* at 2-5.

hospitalizations, and deaths; and development and exacerbation of asthma.[42] Even "[s]hort-term exposure (from less than 1 day up to several days) to $PM_{2.5}$ is likely causally associated with mortality from cardiopulmonary diseases, increased hospitalization and emergency department visits for cardiopulmonary diseases, increased respiratory symptoms, decreased lung function, and changes in physiological indicators for cardiovascular health."[43]

The negative health effects of pollutants produced from indoor gas combustion are well-documented and alarming, and measures such as the City of Berkeley's ordinance are critical to provide better public health outcomes.

III. Gas appliance use results in outdoor emissions that affect outdoor ambient air quality, and contribute to climate change and its related negative health outcomes

In addition to emitting harmful pollutants indoors, gas appliances such as furnaces and water heaters also contribute to outdoor air pollution. As noted above, the burning of fossil fuels releases a variety of criteria pollutants, including nitrogen oxides, particulate matter, sulfur oxides, carbon monoxide, and reactive

[42] 72 Fed. Reg. 20,586, 20,586-87 (Apr. 25, 2007). *See also* U.S. Env't Prot. Agency, *Health and Environmental Effects of Particulate Matter (PM): Health Effects*, https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm (last visited Feb. 4, 2022).
[43] 72 Fed. Reg. 54,112, 54,128 (Sept. 21, 2007).

organic gases.[44] In addition to their effects on indoor air quality, gas appliance pollutants are routinely transported outdoors through ventilation systems or open windows.[45] The use of these appliances also results in direct methane emissions via partially unburnt gas or methane leaks.

A. Criteria pollutants from gas appliances negatively impact outdoor air quality

Fossil fuel appliances in the United States are estimated to emit 425,000 tons of NOx pollution annually.[46] In 2018, residential gas appliances in California alone emitted approximately 15,900 tons of NOx and between 9,000 to 12,000 tons of CO.[47] NOx pollution from residential gas appliances alone accounts for 3 percent of total NOx emissions in the state of California.[48] The Bay Area Air Quality Management District, the agency charged with air pollution control in the region, has recognized that emissions reductions from gas appliances are necessary to improving air quality in the San Francisco Bay Area Air Basin. In the San Francisco Bay Area Air Basin, residential fuel combustion is responsible for almost 4,000 tons of NOx emissions, surpassing NOx pollution from passenger

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[44] Energy & Env't Econ., Inc., *Quantifying the Air Quality Impacts of Decarbonization and Distributed Energy Programs in California* 10 (2021), https://www.ethree.com/wp-content/uploads/2022/01/CPUC-Air-Quality-Report-FINAL.pdf.
[45] Zhu et al., *supra* note 6, at 34.
[46] Dennison et al., *supra* note 11, at 5.
[47] Zhu et al., *supra* note 6, at 36.
[48] *Id.*

vehicles.[49] As NOx is a precursor pollutant to ground-level ozone, reductions of NOx emissions are critical to ozone-polluted regions such as the San Francisco Bay Area Air Basin.[50] NOx emissions also lead to formation of $PM_{2.5}$.[51] In Alameda County, residential gas appliances emit 101 tons of $PM_{2.5}$ annually.[52] Measures such as the City's ordinance are an important step in reducing emissions that affect outdoor air quality.

B. Greenhouse gas emissions from gas appliances exacerbate health risks related to climate change

The use of fossil gas for indoor combustion is a large source of greenhouse gas emissions, which in turn is a significant contributor to climate change, temperature rise, and the associated harms to human health. Emissions resulting from residential and commercial combustion of gas products for heating and cooking represent approximately 13 percent of total U.S. greenhouse gas (GHG)

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[49] Bay Area Air Quality Mgmt. Dist., *Workshop Report Draft Amendments to Building Appliance Rules –Regulation 9, Rule 4: Nitrogen Oxides from Fan Type Residential Central Furnaces and Rule 6: Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters* 3 (2021), https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/2021-amendments/documents/20210930_01_wsr_rules0904and0906-pdf.pdf.

[50] The San Francisco Bay Area Air Basin is in nonattainment of the state and federal 1-hour and 8-hour ozone standards. Bay Area Air Quality Mgmt. Dist., *Air Quality Standards and Attainment Status*, https://www.baaqmd.gov/about-air-quality/research-and-data/air-quality-standards-and-attainment-status (last visited Feb. 4, 2022).

[51] Zhu et al., *supra* note 6, at 45–46.

[52] *Id.* at 54.

emissions.[53] In the San Francisco Bay Area Air Basin, residential gas combustion emits 5.1 tons of GHG emissions every year,[54] and comprises 37 percent of emissions in the City of Berkeley.[55] Policies such as the City of Berkeley's ordinance should be encouraged in order to combat harmful GHG emissions.

Direct methane emissions from gas appliances are contributing to climate change at an alarming rate. Methane is one of the most pernicious greenhouse gases effecting climate change. Methane has a high potential to contribute to warming global temperatures (global warming potential or "GWP"), 82.5 times that of carbon dioxide.[56] As of 2019, EPA estimated methane emissions from an aggregated category of "stationary combustion" at residential and commercial sources at 24 giga grams (Gg) of methane per year.[57] However, a recent Stanford study estimates that total methane emissions from gas stoves *alone* to be about 28 Gg of methane per year,[58] which is roughly equal to the emissions from 500,000 gas-powered cars.[59] The emissions impact is even more troubling considering that the study found significant methane emissions associated with gas appliances while not in use, suggesting passive, continuous emissions from leaking appliances

[53] U.S. Env't Prot. Agency, *supra* note 9.
[54] Bay Area Air Quality Mgmt. Dist., *supra* note 50, at 3.
[55] City of Berkeley, *supra* note 10, at 2.
[56] IPCC Sixth Assessment Report, *supra* note 7, at 7-125.
[57] Lebel et al., *supra* note 25, at H.
[58] *Id.* at H–I.
[59] *Id.* at G.

and nearby piping.[60] In addition to the 28 Gg of methane emissions from gas stoves, the same research team found in a prior study that methane emissions from gas-powered water heaters was 82 Gg of methane per year.[61] As made evident by the most recent Stanford study, EPA neither accounts for leaks from appliances nor reports emissions from specific residential natural gas appliances. Accordingly, while EPA has estimated methane emissions from *total* residential stationary sources at 24 Gg of methane per year, these recent studies estimate emissions could be as high as 110 Gg of methane per year from stoves and water heaters *alone*, and are likely much higher when taking into account emissions from gas-powered furnaces. GHG emissions from gas appliances are contributing more to global warming than previously understood, accelerating the effects of climate change and associated impacts on human health.

Berkeley, the San Francisco Bay Area, and other parts of California are already experiencing severe impacts of climate change, including warmer temperatures, longer and more frequent droughts, and longer, more intense wildfire seasons.[62] Climate change effects, such as extreme heat events and increased air

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[60] *Id.* at F.
[61] Lebel et al., *supra* note 8.
[62] Cal. Energy Comm'n, *California's Changing Climate 2018* (2018), https://www.energy.ca.gov/sites/default/files/2019-11/20180827_Summary_Brochure_ADA.pdf.

pollution from ozone formation and wildfires, pose major threats to public health.[63] From 1950 to 2005, the average annual maximum temperature in the Bay Area increased by 1.7 degrees Fahrenheit.[64] This trend is expected to continue with the average yearly temperature in the region projected to increase between 4.1 and 6.2 degrees Fahrenheit by 2100.[65] The higher temperatures and more frequent and intense wildfires both contribute to increased ozone and particulate matter pollution, which lead to increased incidences of respiratory illnesses, asthma, heat-related illnesses and mortality.[66] One study estimated that there were 12,000 annual average premature heat-related deaths in the United States during the 2010s.[67] This figure is likely to increase in the context of average temperature rise.[68] By advancing electrification, Berkeley's ordinance will help expand access to efficient cooling solutions to alleviate direct heat-related harms and reduce greenhouse gas emissions from buildings, helping to mitigate global warming.[69]

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[63] Cal. Energy Comm'n, *California's Fourth Climate Change Assessment: San Francisco Bay Area Region Report* 7 (2018), https://www.energy.ca.gov/sites/default/files/2019-11/Reg_Report-SUM-CCCA4-2018-005_SanFranciscoBayArea_ADA.pdf.
[64] *Id.* at 6.
[65] *Id.* at 61.
[66] *Id.* at 58, 61.
[67] Drew Shindell et al., *The Effects of Heat Exposure on Human Mortality Throughout the United States*, 4 GeoHealth 1, 7 (2020).
[68] *Id.*
[69] *See* Lacey Tan & Mohammad H. Fathollahzadeh, RMI, *Why Heat Pumps are the Answer to Heat Waves* (2021), https://rmi.org/why-heat-pumps-are-the-answer-to-heat-waves/ (last visited Feb. 4, 2022).

Ground-level ozone is projected to increase due to climate change, with the largest increases in California and the central United States.[70] Exposure to ground-level ozone is associated with diminished lung function, increased hospital admissions and emergency room visits for asthma, and increases in premature deaths.[71] A study assessing health impacts from 2000 to 2002 ozone levels in the United States estimated that health-related costs of these ozone exceedances were as much as $6.5 billion.[72] These health costs are likely to increase as more regions in the United States face rising temperatures and greater ozone pollution.

Climate change also has the potential to lead to higher pollen concentration and longer pollen seasons,[73] causing more people to suffer from health effects due to pollen and other allergens.[74] For example, asthma has been exacerbated by elongation of the ragweed pollen season in central North America, which has grown thirteen to twenty-seven days longer since 1995 because of higher

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[70] Neal Fann et al., *The geographic distribution and economic value of climate-change ozone health impacts in the United States in 2030*, 65 J. Air & Waste Mgmt. Ass'n 570, 574 (2015).
[71] Ctrs. for Disease Control & Prevention, *Air Pollution*, https://www.cdc.gov/climateandhealth/effects/air_pollution.htm (last visited Feb. 4, 2022).
[72] *Id.*
[73] William R.L. Anderegg et al., *Anthropogenic climate change is worsening North American pollen seasons*, 118 Proc. Nat'l Acad. Scis. e2013284118 (2021).
[74] Ctrs. for Disease Control & Prevention, *Allergens and Pollen*, https://www.cdc.gov/climateandhealth/effects/allergen.htm (last visited Feb. 4, 2022).

temperatures and greater carbon dioxide levels.[75] A recent study regarding allergens in the Bay Area found that the tree pollen and mold seasons have increased by around half of a week each year from 2002 through 2019,[76] exacerbating harms due to those allergens. Climate change also leads to shifts in precipitation patterns, more frost-free days, warmer seasonal air temperatures, and more CO_2 in the atmosphere, which can affect a host of conditions that exacerbate allergic reactions.[77]

Health impacts from climate change are a present, not future threat, and these risks will be compounded absent immediate, deep reductions in GHG emissions.[78] GHG emissions from gas appliances are even greater than previously known, and it is evident that the continued use of fossil gas indoors will only accelerate global climate change and the associated risks to public health.

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[75] Lewis Ziska et al., *Recent Warming by Latitude Associated with Increased Length of Ragweed Pollen Season in Central North America*, 108 Proc. Nat'l Acad. Scis. 4248, 4248 (2011).
[76] Bibek Paudel et al., *Increased duration of pollen and mold exposure are linked to climate change*, 11 Sci. Reps. 12816 (2021).
[77] Ctrs. for Disease Control & Prevention, *supra* note 75.
[78] IPCC Sixth Assessment Report, *supra* note 7, at SPM-17, SPM-40 (noting that GHG reduction scenarios "with very low or low GHG emissions . . . lead within years to discernible effects on greenhouse gas and aerosol concentrations, and air quality, relative to high and very high GHG emissions scenarios.").

IV. Indoor and outdoor air pollution related to gas appliance usage exacerbates health risks to vulnerable populations, low-income communities, and communities of color

Pollution from gas appliances can result in severe health consequences for vulnerable populations, including children, the elderly, individuals with respiratory illnesses, and communities of color who bear greater indoor and outdoor air pollution burdens. Demographics, including age, ethnicity, and socioeconomic status, are correlated with disproportionate individual health risk from outdoor air pollution,[79] which in turn exacerbates inequities in risks from exposure to pollution caused by gas appliance use.

The link between gas stoves and childhood asthma has been well-known in the public health community for almost three decades. A 1992 study found that children exposed to higher levels of indoor NO_2—at an increment "comparable to the increase resulting from exposure to a gas stove"—had an elevated risk of respiratory illness.[80] More recently, a 2013 meta-analysis of 41 studies, spanning 36 years of research, demonstrated that children living in homes with gas stoves had a 42 percent higher risk of experiencing asthma symptoms and, over their

[79] Am. Lung Ass'n, *State of the Air: Populations at Risk*, https://www.lung.org/research/sota/key-findings/people-at-risk (last visited Feb. 4, 2022).
[80] Vic Hasselblad et al., *Synthesis of environmental evidence: Nitrogen dioxide epidemiology studies*, 42 J. Air & Waste Mgmt. Ass'n 662, 662 (2012).

lifetime, a 24 percent increase in the risk of being diagnosed with asthma.[81] Children aged four and under who are exposed to indoor nitrogen dioxide from gas appliances are also more likely to experience impaired cognitive function and are at greater risk of developing attention-deficit or hyperactivity disorder symptoms.[82] In 2016, EPA determined that there is a causal relationship between short-term exposure to NO_2 and respiratory effects, and likely a causal relationship between long-term exposure to NO_2 and the development of asthma in children.[83] In making this finding, EPA reviewed studies that showed even small increases in short-term exposure of indoor NO_2—such as exposure generated from indoor gas stove use—can increase asthma risks for children.[84]

Other vulnerable populations, such as the elderly and individuals with existing respiratory illnesses such as asthma, cardiovascular disease, or chronic obstructive pulmonary disease, also experience greater adverse health effects from indoor air pollution. For adults with asthma, NO_2 exposures not much higher than

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[81] Yu A. Tan et al., RMI, *Decarbonizing Homes: Improving Health in Low-Income Communities through Beneficial Electrification* 17 (2021) (citing Weiwei Lin et al., *Meta-Analysis of the Effects of Indoor Nitrogen Dioxide and Gas Cooking on Asthma and Wheeze in Children*, 42 Int'l J. Epidemiology 1724 (2013)).
[82] Seals et al., *supra* note 3, at 13 (citing Eva Morales et al., *Association of Early-life Exposure to Household Gas Appliances and Indoor Nitrogen Dioxide With Cognition and Attention Behavior in Preschoolers*, 169 Am. J. Epidemiology 1327 (2009)).
[83] 2016 NOx ISA, *supra* note 36, at lxxxii, Table ES-1.
[84] Seals et al., *supra* note 3, at 12 (citing Kathleen Belanger et al., *Household levels of nitrogen dioxide and pediatric asthma severity*, 24 Epidemiology 320 (2013)).

peak outdoor 1-hour concentrations can exacerbate symptoms.[85] This is particularly troubling considering that gas stoves or ovens can produce levels of NO_2 exceeding the legally acceptable outdoor 1-hour concentration limit within a matter of minutes.[86] A study published last year concluded that elderly adults who experience long-term exposure to even low concentrations of $PM_{2.5}$ and NO_2 are at increased risk for pneumonia, stroke, and cardiovascular conditions.[87]

Throughout the United States, communities of color and low-income communities bear disproportionate pollution burdens and are more likely to live in areas with high levels of air pollution. In 2014, a University of Minnesota study found that outdoor NO_2 concentrations are 38 percent higher in communities of color in the United States, compared to white communities.[88] Communities forced to breathe these elevated levels of pollution face serious health consequences, and one study has estimated that reducing nonwhites' NO_2 concentrations to levels experienced by whites would reduce ischemic heart disease mortality by around 7,000 deaths per year.[89]

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[85] *Id.* at 12 (citing 2016 NOx ISA, *supra* note 36, at 1-18, 1-31, 5-240).
[86] Lebel et al., *supra* note 25, at G.
[87] Mahdieh D. Yazdi et al., *Long-Term Association of Air Pollution and Hospital Admissions Among Medicare Participants Using a Doubly Robust Additive Model*, 143 Circulation 1584 (2021).
[88] Lara P. Clark et al., *National Patterns in Environmental Justice and Inequality: Outdoor NO_2 Air Pollution in the United States*, 9 PLOS ONE e94431 (2014).
[89] *Id.*

Another recent study showed that communities of color, regardless of income, are also exposed to more outdoor $PM_{2.5}$ pollution from a variety of sources, including power plants, industrial facilities, agricultural activities, vehicles, and residential gas combustion.[90] The study also showed that the relative disparity in exposure to outdoor $PM_{2.5}$ caused by residential gas combustion is among the largest, where people of color are exposed to almost twice as much $PM_{2.5}$ than whites.[91] Indeed, residential gas combustion showed the highest relative racial-ethnic disparity of the 14 source categories studied—more than power plants, vehicles, and industrial sources.[92]

Housing conditions in low-income communities contribute socioeconomic disparities in household exposure to indoor air pollution. For example, smaller units, higher occupant density, and inadequate ventilation all contribute to higher levels of NO_2 in lower-income, multifamily buildings.[93] As noted above, increased levels of NO_2 exposure can lead to cardiovascular effects, diabetes, cancer, and

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[90] Christopher W. Tessum et al., *PM2.5 polluters disproportionately and systemically affect people of color in the United States*, 7 Sci. Advances eabf4491 (2021), https://advances.sciencemag.org/content/suppl/2021/04/26/7.18.eabf4491.DC1.
[91] *Id.* at 1, supplementary data file S2.
[92] Dennison et al., *supra* note 11, at 8.
[93] Seals et al., *supra* note 3, at 14 (citing Gary Adamkiewicz et al., *Moving Environmental Justice Indoors: Understanding Structural Influences on Residential Exposure Patterns in Low-Income Communities*, 101 Am. J. Pub. Health 238 (2011)).

reproductive harms[94] and are exacerbated by the added exposure to both indoor and outdoor air pollution in vulnerable communities.

The impact of indoor and outdoor air pollution on human health has been made even more apparent since the COVID-19 pandemic. Numerous studies have confirmed that communities living in regions with high levels of outdoor air pollution are more vulnerable to adverse health outcomes, including morbidity and mortality, from COVID-19.[95]

V. Ordinances such as the City of Berkeley's are critical to reducing pollution and protecting public health

Reducing fossil fuel end uses in homes is a critical public health issue that should be addressed by governments and agencies responsible for safeguarding human health and welfare. The City of Berkeley's ordinance ending gas hookups in new buildings is an effective policy that will reduce indoor and outdoor air pollution in the region and eliminate the unacceptable health risks that stem from the use of gas appliances.

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[94] *Id.* at 12.

[95] Xiao Wu et al., *Exposure to Air Pollution and COVID-19 Mortality in the United States*, 4 Sci. Advances eabd4049 (2020). *See also* Tony Barboza, *Does Air Pollution Make You More Susceptible to Coronavirus? California Won't Like the Answer*, L.A. Times (Mar. 21, 2020), https://www.latimes.com/california/story/2020-03-21/coronavirus-air-pollution-health-risk; Lisa Friedman, *New Research Links Air Pollution to Higher Coronavirus Death Rates*, N.Y. Times (Apr. 7, 2020), https://www.nytimes.com/2020/04/07/climate/air-pollution-coronavirus-covid.html.

A. Existing policies do not adequately target indoor air pollution or gas appliance contributions to outdoor air pollution

Policies that fall short of eliminating gas appliances only mitigate indoor air pollution at best and are inadequate to address the significant risk to public health associated with fossil fuel end uses in buildings. For example, as noted above, the most effective measure to reduce pollution when gas stoves are present is to ensure proper exhaust ventilation. But gas stoves are not subject to uniform venting codes and are not even required to be vented outdoors in certain U.S. cities and states. Moreover, the effectiveness of ventilation depends on proper installation, maintenance, and operation.[96] Due to this potential variability in installation and use, venting can capture as little as 15 percent of pollutants from gas stoves.[97] Reliance on ventilation and continued use of indoor combustion appliances also does not abate the risk of pollutant backdraft and associated increased concentrations of carbon monoxide that result in increased rates of CO poisoning.[98] The Centers for Disease Control and Prevention (CDC) estimated 393 deaths in the United States from unintentional, non-fire-related CO poisoning from

[96] Seals et al., *supra* note 3, at 16.
[97] *Id.*
[98] Zhu et al., *supra* note 6, at 14 (citing Vi H. Rapp et al., Lawrence Berkeley Nat'l Lab'y, *Assessment of Literature Related to Combustion Appliance Venting Systems* (2015)).

consumer products in 2015, and, in California, there were an estimated 643 emergency department visits in 2016 due to non-fire-related CO poisoning.[99]

B. Building electrification will result in overall better health outcomes and monetized health benefits

Conversion to electric appliances will have direct and substantial effects on indoor and outdoor pollution and abate related negative health outcomes. Building electrification addresses the many health risks associated with residential fuel combustion because electric appliances provide the greatest decrease in pollution as compared to gas appliances. Homes with gas stoves have been found to have NO_2 concentrations 50 to 400 percent higher than homes with electric stoves.[100] Electric heat pumps, for example, do not produce combustion pollutants or require venting and therefore do not contribute to indoor and outdoor air pollution. A 2016 Lawrence Berkeley National Laboratory study showed that after subtracting outdoor contribution, all-electric homes had NO_x concentrations close to zero.[101] The first published intervention study to remediate indoor NO_2 concentrations from gas stoves found that replacing a gas stove with an electric stove decreased median NO_2 concentrations by 51 percent in the kitchen, and also decreased NO_2

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[99] *Id.*
[100] Seals et al., *supra* note 3, at 11.
[101] *Id.* at 8, Ex. 1 (citing Nasim A. Mullen et al., *Results of California Healthy Homes Indoor Air Quality Study of 2011-2013: Impact of Natural Gas Appliances on Air Pollutant Concentrations*, 26 Indoor Air 231, 234 (2016)).

emissions throughout the home.[102] Although cooking food on any stove type emits some $PM_{2.5}$, tests show $PM_{2.5}$ emissions from gas stoves can be two times higher than from electric stoves.[103]

A growing body of studies have also shown that building electrification will result in markedly better health outcomes and sizable monetized health benefits. According to a 2020 UCLA study, the reduction of $PM_{2.5}$ emissions associated with building electrification is estimated to prevent 125 deaths, 196 incidences of acute bronchitis, and 115 cases of chronic bronchitis in the San Francisco Bay Area Air Basin alone, resulting in over $1.2 billion in monetized benefit per year.[104] That same study also estimated that the monetized benefits for all outdoor air quality-related health effects directly linked to building electrification in California were close to $3.5 billion dollars annually.[105] The 2020 UCLA study found that under a "high building electrification" scenario, building electrification was projected to result in lower $PM_{2.5}$ concentrations, particularly in winter, yielding a health savings of approximately $200 million over 10-day episodes in

[102] *Id.* at 17 (citing Laura M. Paulin et al., *Home interventions are effective at decreasing indoor nitrogen dioxide concentrations*, 24 Indoor Air 416 (2014)).
[103] *Id.* at 8, Ex. 1.
[104] Zhu et al., *supra* note 6, at 56.
[105] *Id.* at 39.

summer and winter, due to mitigation of ozone and $PM_{2.5}$.[106] Another study conducted on behalf of the California Energy Commission found that electrification of multiple sectors—including buildings—in 2050 would result in $108 billion in annual health benefits for California from reductions in $PM_{2.5}$ and ozone.[107]

Electrification can address the environmental justice implications of indoor and outdoor appliance pollution discussed above. As noted above, vulnerable communities are at greater risk of developing cardiovascular and respiratory illnesses from indoor air pollution. Low-income communities and communities of color who already experience greater outdoor pollution burdens are more likely to be disproportionately affected by indoor air pollution.[108] A study of two public housing apartment buildings found significant decreases in multiple indoor exposures and improved health outcomes among participants who moved from conventional apartments to "green" housing.[109] The researchers noted that NO_2

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[106] *Id.* at 33 (citing Dan Aas et al., Cal. Energy Comm'n, *The Challenge of Retail Gas in California's Low Carbon Future: Technology Options, Customer Costs, and Public Health Benefits of Reducing Natural Gas Use* (2020)).
[107] Marcus Alexander et al., Cal. Energy Comm'n, *Air Quality Implications of an Energy Scenario for California Using High Levels of Electrification* 27 (2019), https://www.energy.ca.gov/sites/default/files/2021-06/CEC-500-2019-049.pdf.
[108] Seals et al., *supra* note 3, at 15.
[109] *Id.* at 15 (citing Meryl D. Colton et al., *Indoor Air Quality in Green Vs Conventional Multifamily Low-Income Housing*, 48 Env't Sci. & Tech. 7833, 7837 (2014)).

concentrations decreased by 65 percent and $PM_{2.5}$ concentrations decreased by 57 percent, and stated that the change from gas to electric stoves could be a contributor to the evidenced reductions.[110] The growing body of research assessing these disproportionate health risks indicate that building electrification policies can be an important tool to alleviate existing health inequities compounded by pollution from gas appliances.

CONCLUSION

For the foregoing reasons, *amici* respectfully request that the Court deny Plaintiff's appeal, and instead affirm the ruling of the district court in favor of the City of Berkeley.

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[110] *Id.*