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Provide the docket's number.	G999/CI-21-565
Leave a comment on the docket. *	Please find attached our comments for Docket No. G999/CI-21-565: In the Matter of a Commission Evaluation of Changes to Natural Gas Utility Regulatory and Policy Structures to Meet State Greenhouse Gas Reduction Goals. Thank you for the opportunity to submit input on this important issue.
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July 8, 2025

RE: **In the Matter of a Commission Evaluation of Changes to Natural Gas Utility Regulatory and Policy Structures to Meet State Greenhouse Gas Reduction Goals**

PUC Docket Number(s): G999/CI-21-565

Dear Executive Secretary, Minnesota Public Utilities Commission,

COPAL (Comunidades Organizando el Poder y la Acción Latina), Ayada Leads, Health Professionals for a Healthy Climate (HPHC), and Curtis Nordgaard (an independent commenter), together with the voices of the frontline communities we serve, appreciate the opportunity to provide these comments in response to the Minnesota Public Utilities Commission's May 5, 2025, Notice of Comment Period regarding possible modifications to gas line extension policies for rate-regulated gas utilities.[1]

Our comments are grounded in both community experience and research and reflect our strong opposition to the continuation of subsidized gas line extension allowances. These policies incentivize the expansion of fossil gas infrastructure at a time when Minnesota law and climate science demand the opposite. They impose unnecessary and unjust costs on existing ratepayers, especially those in low-income and BIPOC communities, while locking in harmful emissions, health risks, and long-term financial liabilities.

As established by the Minnesota Legislature in 2021, the Commission is directed to evaluate the current natural gas regulatory and policy structures and ensure their alignment with the state's greenhouse gas (GHG) reduction goals.[2] The Future of Gas proceeding opens a broad inquiry into how natural gas utilities should plan for long-term energy needs in a decarbonizing economy.[3] This proceeding has not only raised critical questions about the economic and climate viability of continued investment in gas infrastructure, but also about how utility planning can proactively protect low-income and frontline communities.

These communities must neither be left behind in the transition nor disproportionately locked into fossil fuel dependency through policies such as gas line extension allowances. This is particularly important, knowing that this fossil fuel dependency poses significant health risks for residents reliant on home gas systems, as detailed below.

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[1] In the Matter of a Commission Evaluation of Changes to Natural Gas Utility Regulatory and Policy Structures to Meet State Greenhouse Gas Reduction Goals, Notice of Comment Period, Minn. Pub. Util. Comm'n, Docket No. G-999/CI-21-565 (May 5, 2025).

[2] Minnesota Laws 2021 1st Special Session, Chapter 4, Article 8, Section 27

[3] As initiated in the Commission's February 17, 2023 Order in Docket No. G999/CI-21- 135

Commission Questions

The Commission's current request for comments on gas line extension policies presents a timely and important opportunity to reassess these longstanding practices. Reforming line extension allowances is essential to ensuring that Minnesota's clean energy transition prioritizes affordability, equity, and public health, not simply continued infrastructure expansion. We appreciate the Commission's invitation to respond to the specific questions outlined in this docket. As community-based organizations, we have come together to offer comments on several of the key issues raised. Our responses are grounded in lived community experiences, public health evidence, as well as Minnesota's climate and just energy goals.

1. Should the Commission consider any modifications to how gas utilities calculate free footage allowance and other costs related to gas main and service line extensions?

Yes. Current calculations obscure the full cost of infrastructure expansion and unfairly place financial risk on existing ratepayers. The Commission should consider eliminating or significantly reducing free footage allowances and require utilities to internalize the full infrastructure costs for new connections. This would ensure that new customers, particularly developers, pay their fair share, and that utilities no longer promote system growth contrary to state climate policy.

Gas line extension policies currently subsidize new fossil infrastructure with "free footage allowances," the costs of which are socialized across all ratepayers, including many who cannot afford and do not benefit from these connections. This perpetuates economic inequity and unfairly burdens low-income households.

Subsidizing gas infrastructure through new natural gas line extensions in Minnesota's residential developments while simultaneously promoting a statewide net-zero and climate framework creates a policy contradiction that risks locking in fossil fuel dependence for decades. These line extensions are not just short-term infrastructure investments; they represent long-lived assets with costs that will increasingly be borne by shrinking ratepayer bases as more Minnesotans transition to electric heating and appliances. This misalignment threatens to create stranded assets and exacerbate economic and environmental disparities, especially for those least able to decarbonize.

I. Equity Concerns

Rising household energy costs are placing significant pressure on Minnesota families, especially low-income and BIPOC households. Between January 2021 and January 2023, piped gas prices in the Ninth Federal Reserve District, including Minnesota, increased by 57%, significantly outpacing electricity costs over the same

period (24%).[4] Nearly one in ten Minnesota households reported difficulty paying their energy bills in early 2023 among the highest rates in the district.[5] These burdens fall disproportionately on residents earning less than $75,000 annually, who make up three-quarters of those struggling with energy costs and particularly on Black and Hispanic households, who report energy insecurity at rates two to three times higher than white households.[6] Despite the state's Gas Affordability Program, which caps gas spending at 6% of income for eligible customers, more than 130,000 households still required supplemental assistance through the Low Income Home Energy Assistance Program (LIHEAP) in 2024.[7]

Many low-income, rural, and BIPOC communities in Minnesota face disproportionate barriers to participating in the clean energy transition. Although the state offers rebates and incentives through programs like the Weatherization Assistance Program (WAP)[8], EAP[9], and utility-sponsored electrification programs, access remains deeply unequal. Residents in these communities may be unable to take advantage of such programs due to:

- Income constraints and high upfront costs.
- Geographic exclusion, including limited service availability in rural or tribal areas.
- Language and digital literacy barriers make applications difficult to navigate.
- Fear or distrust of sharing personal data with government agencies.

Meanwhile, line extension subsidies often benefit developers of new housing, frequently in suburban or higher-income areas, effectively channeling public resources toward expanding fossil fuel infrastructure that low-income households may not even have the option to refuse or replace. To avoid deepening these inequities, we ask the Commission to reevaluate policies that encourage gas expansion and instead:

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[4] Federal Reserve Bank of Minneapolis, *Rising Household Energy Costs Affect Lower-Income and Non-White Residents Most*, March 1, 2023, https://www.minneapolisfed.org/article/2023/rising-household-energy-costs-affect-lower-income-and-non-white-residents-most.
[5] Ibid.
[6] Ibid.
[7] U.S. Department of Health and Human Services, LIHEAP Clearinghouse, *Minnesota State Snapshot (FY 2025)*, https://liheapch.acf.hhs.gov/profiles/Minn.htm.
[8] Minnesota Department of Commerce, *Weatherization Assistance Program (WAP)*, retrieved from Minnesota Commerce Energy Consumer Assistance webpage, https://mn.gov/commerce/energy/consumer-assistance/wap/.
[9] Minnesota Department of Commerce, *Energy Assistance Program*, Minnesota Commerce – Energy and Consumer Assistance, retrieved from https://mn.gov/commerce/energy/consumer-assistance/energy-assistance-program/.

- Prioritize investments in equitable electrification, including heat pumps, induction stoves, electric vehicles, etc.

- Ensure that utility line extension rules reflect the full lifecycle cost of new gas infrastructure.

- Redirect subsidies toward community-based programs that offer hands-on assistance and clear, accessible paths to electrification, weatherization, customer support, and education.

- Protect renters and residents of manufactured homes from being left behind in the energy transition. Focus specifically on protecting low-income and BIPOC communities.

Without a clear shift in priorities, Minnesota risks locking underserved communities into higher-emission, higher-cost energy systems, while others move forward into a cleaner, more affordable future. Additionally, the Commission must confront the disproportionate risks of gas leaks, which can impact both air quality and safety. In some cities, these leaks occur at higher rates in neighborhoods with a higher proportion of residents of color and less often in neighborhoods with higher income[10].

2. What factors or conditions would justify changes?

I. Line Extensions Undermine Minnesota's Net-Zero Goals

The natural gas sector is one of Minnesota's fastest-growing sources of climate change.[11] Combustion of fossil fuels is the leading driver of greenhouse gas (GHG) emissions, and achieving the deep emissions reductions needed to avoid the worst climate outcomes requires a rapid phaseout of fossil fuel use.[12] Residential and commercial emissions from natural gas have increased by 21% and 48%, respectively, since 2005.[13] In response, Minnesota has adopted climate goals such as a 50% reduction in economy-wide GHG emissions by 2030, net-zero emissions by 2050, and a 50%

[10] Weller, Z. D., Im, S., Palacios, V., Stuchiner, E., & von Fischer, J. C. (2022). Environmental injustices of leaks from urban natural gas distribution systems: Patterns among and within 13 U.S. metro areas. *Environmental Science & Technology*, 56(12), 8599–8609.
[11] Mariko Yatsuhashi, "The Need for Natural Gas Decarbonization in Minnesota," Center for Energy and Environment, 2023, https://www.mncee.org/need-natural-gas-decarbonization-minnesota.
[12] *Causes and Effects of Climate Change*, U.N. Climate Action, https://www.un.org/en/climatechange/science/causes-effects-climate-change (last visited Jan. 10, 2024).
[13] MPCA, "Minnesota Greenhouse Gas Inventory," State.mn.us, 2025, https://data.pca.state.mn.us/views/Greenhousegasemissionsdata/Sectordetails?%3Aembed=y&%3AisGuestRedirectFromVizportal=.

reduction in emissions from existing buildings by 2035.[14] Additionally, there has been an implementation of great laws, such as the Natural Gas Innovation Act (NGIA) and the Energy Conservation and Optimization (ECO) Act.[15] Making electrification and fuel switching explicit state priorities.

Nevertheless, current line extension policies undermine these goals. Line extension allowances function as subsidies that enable new gas customers, often developers or builders, to connect to the gas distribution system at little or no personal cost. The majority of these infrastructure costs are instead placed on existing ratepayers. For instance, Xcel Energy currently offers 80 feet of main extension and 75 feet of service line extension at no cost to the new customer.[16] These allowances distort the true costs of new fossil fuel infrastructure, promote unnecessary system expansion, and shift the financial burden onto households who may be trying to move off gas altogether, and households who cannot afford the cost.

We therefore urge the Commission to evaluate Minnesota's current trajectory and align its decisions with broader decarbonization and affordability strategies.

- Misalignment with Minnesota's GHG reduction mandates and electrification policies.
- Financial risk to existing ratepayers in a shrinking gas customer base.
- Rising energy costs and disproportionate burdens on vulnerable households.
- Availability of cost-effective and health-protective electric alternatives.
- Precedents from other states phasing out similar policies.
- Electrification of space and water heating is both feasible and cost-competitive with gas in most residential applications, particularly when paired with weatherization.
- Gas line extensions create stranded asset risk and ratepayer liability as more customers shift to electric solutions.

3. How would any proposed changes affect new connecting customers and other ratepayers?

Eliminating subsidies would increase cost transparency and encourage more sustainable, long-term decisions by builders and developers. While new customers may face higher up-front costs, existing customers would no longer be forced to

[14] Caitlin Eichten, "Now Is the Time to Reevaluate Subsidized Gas Line Extensions in Minnesota - Fresh Energy," Fresh Energy, March 24, 2025, https://fresh-energy.org/now-is-the-time-to-reevaluate-subsidized-gas-line-extensions-in-minnesota.
[15] Caitlin Eichten, *Time to Reevaluate Subsidized Gas Line Extensions*, Fresh Energy (Mar. 24, 2025)
[16] Joe Dammel, "Xcel Energy Rate Case Presents an Opportunity to Co-Create Minnesota's Energy Future," Fresh Energy, October 3, 2022, https://fresh-energy.org/xcel-energy-rate-case-presents-an-opportunity-to-co-create-minnesotas-energy-future.

cross-subsidize fossil fuel expansion. This shift would accelerate the transition to cleaner technologies and reduce long-term financial liabilities for all.

4. What lessons should the Commission consider from proceedings in other states related to this matter?

In this context, gas line extension allowances—ratepayer-funded subsidies that cover the costs of extending gas infrastructure to new customers have long been implemented under the assumption that system expansion benefits all by growing the customer base and spreading fixed costs.[17] Historically, such allowances were justified by assumptions that infrastructure expansion would benefit all ratepayers by spreading fixed costs over a growing customer base. But these assumptions no longer hold in a decarbonizing energy system, where electrification is increasingly cost-effective, and the need for equitable and climate-aligned utility investment is urgent.[18]Other states, such as California, Colorado, Connecticut, Oregon, New York, Washington [1] [2], and Massachusetts, are already phasing out line extension allowances to meet climate mandates and reduce system costs. These actions reflect a growing national consensus: subsidizing fossil fuel expansion is incompatible with both climate responsibility and ratepayer fairness. Many commissions have recognized that these policies are no longer financially justifiable or climate-compatible. The Commission should consider the phased approaches and stakeholder engagement models used elsewhere as templates for Minnesota.

5. Are there other issues or concerns related to this matter?

Yes. There are two primary concerns: the first is related to health impacts, and the second involves acknowledging, valuing, and considering the lived experiences and input from our community members when making a decision on line extension policies. The health risks associated with gas appliances, such as elevated indoor air pollution and increased incidence of asthma, cardiovascular disease, and other health conditions, are well established, particularly for children and older adults. These harms fall disproportionately on low-income and BIPOC households. Continuing to subsidize gas infrastructure only deepens these disparities and extends the burden on already vulnerable communities. For these comments, we have gathered multiple health research and community statements that reflect lived experience and support our response.

I. Health and Safety Impacts of Gas Line Extensions

We urge the Commission to eliminate or highly reduce current line extension allowances in part due to the public health risks posed by expanding fossil gas infrastructure. Decades of peer-reviewed research outlined below demonstrate that indoor gas combustion significantly elevates levels of indoor and outdoor air pollutants

[17] Caitlin Eichten, *Time to Reevaluate Subsidized Gas Line Extensions*, Fresh Energy (Mar. 24, 2025)
[18] Ibid.

at concentrations that pose significant risk to the entire body, and the pulmonary, cardiovascular, and ocular systems in particular.

This evidence demonstrates that expanding gas infrastructure not only violates principles of public health protection but also continues to disproportionately harm historically marginalized communities. We briefly review a representative portion of the evidence that directly links residential use of natural gas in homes to air quality and health impacts in the next section.

1.1. Natural gas, indoor air, and health

Nearly all natural gas used in the residential setting is consumed through combustion. This process generates a suite of pollutants, similar to any other combustion process.[19]

1.1.1. Natural gas appliances create significant indoor air pollution.

Research consistently finds gas cooking appliances to contribute to high indoor levels of harmful air pollutants. These pollutants include Carbon Monoxide (CO)[20], ultrafine particulate matter (UFPs)[21], $PM_{2.5}$[22], Methane (CH_4)[23], and Nitrogen Dioxide (NO_2)[24], along with other Nitrogen Oxides (NO_x)[25], including Nitrous Acid (HONO)[26] and Nitric Oxide (NO)[27]. While this impact tends to increase with use, one study found that gas stoves leak high levels of methane and NO_x, even when turned off[28]. Many of these studies find the levels of these air pollutants to exceed concentrations considered safe by reputable agencies (for instance, the NAAQs by the US EPA). Many of these studies also examined the pollutants from cleaner alternatives like electric and induction appliances, which they found to emit lower levels than gas appliances.

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[19] Nassikas NJ, et al., "Indoor Air Sources of Outdoor Air Pollution: Health Consequences, Policy, and Recommendations: An Official American Thoracic Society Workshop Report," *Annals of the American Thoracic Society*, vol. 21, no. 3, March 2024, pp. 365–376.

[20] Mullen NA, Li J, Russell ML, Spears M, Less BD, Singer BC, "Results of the California Healthy Homes Indoor Air Quality Study of 2011-2013: Impact of Natural Gas Appliances on Air Pollutant Concentrations," *Indoor Air*, vol. (2), pp. 231–245.

[21] Buonanno, G., Morawska, L., & Stabile, L., "Particle Emission Factors During Cooking Activities," *Atmospheric Environment*, vol. 43, pp. 3235–3242, 2009.

[22] Zhang, Q., Gangupomu, R. H., Ramirez, D., & Zhu, Y., "Measurement of Ultrafine Particles and Other Air Pollutants Emitted by Cooking Activities," *International Journal of Environmental Research and Public Health*, vol. 7, no. 4, pp. 1744–1759, 2010.

[23] Yang, J., Guan, J., Zhang, X., Chen, S., Guo, Y., Yuan, H., Dai, J., Xu, Q., Zhang, G., Li, Y., Lin, Z., Wu, Y., & Yang, C., "Pollutant emissions and environmental advantages of heating peanut oil by using commercial induction cooktop: A comparative analysis with traditional natural gas stoves," *Environmental Pollution*, vol. 366, p. 125457, 2025.

[24] Cyrys et al., 2000, Lee et al., 2002, Park and Cho, 2010, Mullen et al., 2016, Paulin et al., 2017, Zhu et al., 2020, Wi et al., 2023, Briggs et al. 2024

[25] Mullen et al., 2016, Wu et al., 2025

[26] Lee et al., 2002, Park and Cho, 2010, Wu et al., 2025

[27] Park and Cho, 2010

[28] Lebel, E. D., Finnegan, C. J., Ouyang, Z., & Jackson, R. B., "Methane and NO_x emissions from natural gas stoves, cooktops, and ovens in residential homes," *Environmental Science & Technology*, 2022.

1.1.2. Exposure to these air pollutants has significant health impacts.

Each of these indoor air pollutants is associated with significant health impacts.

Carbon Monoxide (CO): CO can be lethal in enclosed spaces[29], and was found to be associated with higher risk of ED visits and hospitalization for asthma in a 2015 meta-analysis of 87 studies[30], and higher prevalence of childhood asthma in a recent 2022 study[31]. The EPA warns that CO can worsen the health impacts of heart disease, even through outdoor exposure.

Nitrogen Oxides (Including Nitrogen Dioxide (NO_2) and Nitrous Acid (HONO)): There is extensive evidence showing that exposure to NO_2 contributes to asthma in children[32], adults[33], and the general population[34], and is associated with higher rates of nighttime inhaler use[35], wheeze[36], and airflow obstruction[37] in children. NO2 and NOx exposure have been found to be associated with retinal layer thickness difference as well[38].

Particulate Matter (PM): There's substantial research documenting the health impacts of particulate matter exposure, including $PM_{2.5}$ and UFP. Zheng et al's 87-study meta-analysis found short-term PM_{10} and $PM_{2.5}$ exposure to be associated with higher risk of ED visits and hospitalization for asthma[39]. In addition, a 2022 study found PM2.5 exposure to be associated with age-related macular degeneration, and found PM2.5 and PM10 exposure to correlate with retinal layer thickness differences[40]. A 2024

[29] US EPA, 2016

[30] Zheng, X., Ding, H., Jiang, L., Chen, S., Zheng, J., Qiu, M., Zhou, Y., Chen, Q., & Guan, W., "Association between air pollutants and asthma emergency room visits and hospital admissions in time series studies: A systematic review and meta-analysis," *PLOS ONE*, vol. 10, no. 9, e0138146, 2015.

[31] Eghomwanre, A. F., & Oguntoke, O., "Concentrations of indoor gaseous air pollutants and risk factors associated with childhood asthma in Benin City, Nigeria," *Environmental Monitoring and Assessment*, vol. 194, no. 5, p. 391, 2022.

[32] Gruenwald, T., Seals, B., Knibbs, L., Hosgood, D. (2022).

[33] Kang, C. M. (2023). *Impacts of Residential Indoor Air Quality and Environmental Risk Factors on Adult Asthma-Related Health Outcomes in Chicago, IL* [Doctoral dissertation, University of Illinois Chicago]. ProQuest Dissertations Publishing.

[34] Zheng et al., 2015

[35] Paulin, L. M., Williams, D. 'Ann L., Peng, R., Diette, G. B., McCormack, M. C., Breysse, P., & Hansel, N. N. (2017). 24-h nitrogen dioxide concentration is associated with cooking behaviors and an increase in rescue medication use in children with asthma. *Environmental Research*, *159*, 118–123.

[36] Lin et al., 2013

[37] Gaffin et al., 2018

[38] Chua et al., 2022

[39] Zheng et al., 2015

[40] Chua, S. Y. L., Warwick, A., Peto, T., Balaskas, K., Moore, A. T., Reisman, C., Desai, P., Lotery, A. J., Dhillon, B., Khaw, P. T., Owen, C. G., Khawaja, A. P., Foster, P. J., & Patel, P. J. (2022). Association of ambient air pollution with age-related macular degeneration and retinal thickness in UK Biobank. *British Journal of Ophthalmology*, *106*(5), 705–711.

comprehensive review linked PM exposure to a wide variety of ocular conditions and damage, along with worsening of "preexisting ocular conditions[41].

1.1.3. Studies directly link gas appliances to adverse health impacts.

Beyond the research linking gas appliances to air pollutants and linking those air pollutants to health impacts, there is also substantial research directly linking gas appliances to various health impacts.

Asthma is one health condition consistently linked to gas cooking, particularly for children[42]. A 2013 meta-analysis of 41 studies found that living in homes with gas cooking raised the risk of current asthma by 42% in children, and that "per 15 ppb increase in indoor NO_2 level, children have a 15% increased risk of having current wheeze"[43]. One recent estimate determined that 12.7% of childhood asthma cases in the U.S. can be attributed to cooking with natural gas[44]. Gas stoves have long been associated with increased risk of childhood respiratory symptoms[45], and recent epidemiologic studies continue to find a relationship between gas cooking and asthma[46].

Cancer is another health condition linked to gas cooking. Among many other pollutants, burning natural gas in stoves and cooktops produces the known carcinogen benzene[47]. Benzene is a known cause of blood cancers, including childhood leukemia. One analysis published this year found that just the benzene produced by cooking with natural gas could increase childhood cancer risks by 4-16 times[48].

1.1.4. Indoor air pollution from gas stoves has equity implications.

These indoor air quality impacts are also equity issues. Smaller living spaces, like apartments, tend to have higher concentrations of indoor air pollutants from gas appliances compared to larger spaces, and overcrowdedness can further exacerbate this difference in indoor air pollution levels, "particularly since it may affect cooking

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[41] Upaphong, P., Thonusin, C., Wanichthanaolan, O., Chattipakorn, N., & Chattipakorn, S. C. (2024). Consequences of exposure to particulate matter on the ocular surface: Mechanistic insights from cellular mechanisms to epidemiological findings. *Environmental Pollution*, *345*, 123488.

[42] Lin et al., 2013, Bédard, 2023, Han et al., 2023, Gruenwald et al., 2024, Fabian et al., 2014

[43] Lin et al., 2013

[44] Gruenwald, T., Seals, B., Knibbs, L., Hosgood, D. (2022).

[45] Garrett, M. H., Hooper, M. A., Hooper, B. M., & Abramson, M. J. (1998). Respiratory symptoms in children and indoor exposure to nitrogen dioxide and gas stoves. *American Journal of Respiratory and Critical Care Medicine*, *158*(3), 891–895.

[46] Bédard, M. A., Moraes, T. J., Mora, E., et al. (2023). Association between gas stove use and childhood asthma in the Canadian CHILD Cohort Study. *Canadian Journal of Public Health*, *114*(4), 705–708.

[47] Kashtan, Y. S., Lunden, M. M., Lobscheid, A. B., Logue, J. M., & Lebel, E. D. (2023). Gas and propane combustion from stoves emits benzene and increases indoor air pollution. *Environmental Science & Technology*, *57*(26), 9653–9663.

[48] Garg, A., Logue, J. M., Singer, B. C., & Apte, J. S. (2025). Exposure and health risks of benzene from combustion by gas stoves: A modelling approach in U.S. homes. *Journal of Hazardous Materials*, *492*, 137986.

frequency"[49]. One 2022 study found overcrowding to be the strongest asthma predictor of the factors studied, with children living in overcrowded households having 12x the rate of asthma compared to those in uncrowded homes[50]. In addition, Zhu et al. points out that "lower-income families, often renters, do not have resources or abilities to replace and maintain gas appliances, which can cause improper ventilation and/or spillage of combustion pollutants into the living space." One study found the presence of a humidifier and an air conditioner (appliances that are often inaccessible to lower-income families) to be significant predictors of lower indoor HONO levels[51]. These issues mean that low-income communities, who tend to live in smaller, more crowded spaces, with less access to the appliances needed to reduce indoor air pollutant levels, tend to face the most severe health impacts from living with gas appliances.

1.1.4. Venting isn't enough. We need to transition away from gas.

Some studies frame venting as a solution to indoor air pollution from gas appliances[52]. While proper ventilation *is* necessary to reduce health risks—as homes with gas appliances require more airflow to mitigate higher pollution levels—this approach fails to address three key issues:

1. Outdoor air quality impacts (and associated health impacts) of gas appliance use,
2. Increased energy use to power mechanical ventilation and from the resulting loss of heated/cooled air, and
3. Equity concerns, as households on tighter budgets may hesitate to increase ventilation due to the resulting higher energy bills.

Recent studies evaluate tradeoffs of weatherization interventions (reducing energy consumption but harming IAQ) and ventilation interventions (increasing energy consumption but improving IAQ)[53]. One of these studies indicates that while ventilation is an important intervention to improve indoor air quality, "ventilation standards may not be sufficient to protect against IAQ disbenefits for residents exposed to strong indoor sources (e.g., heavy cooking) and could lead to net increases in energy costs"[54].

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[49] Zhu, Y., Connolly, R., Matthew, T., & Wang, Z. (2020). *Effects of Residential Gas Appliances on Indoor and Outdoor Air Quality and Public Health in California*. UCLA Fielding School of Public Health.
[50] Eghomwanre and Oguntoke, 2022
[51] Lee, K., Xue, J., Geyh, A. S., Ozkaynak, H., Leaderer, B. P., Weschler, C. J., & Spengler, J. D. (2002). Nitrous acid, nitrogen dioxide, and ozone concentrations in residential environments. *Environmental Health Perspectives*, 110(2), 145–150.
[52] Chan et al 2019, Kile et al, 2014
[53] Underhill, L. J., Dols, W. S., Lee, S. K., Fabian, M. P., & Levy, J. I. (2020). Quantifying the impact of housing interventions on indoor air quality and energy consumption using coupled simulation models. *Journal of Exposure Science & Environmental Epidemiology*, 30(3), 436–447; and Underhill, L. J., Milando, C. W., Levy, J. I., Dols, W. S., Lee, S. K., & Fabian, M. P. (2019). Simulation of indoor and outdoor air quality and health impacts following installation of energy-efficient retrofits in a multifamily housing unit. *Building and Environment*, 170, 106507.
[54] Underhill et al., 2020

To balance energy efficiency and affordability with health protection, simply venting pollutants outdoors isn't enough; we must prevent their release in the first place. This means halting new gas appliance sales, replacing existing ones with electric or induction alternatives, and using higher ventilation as an interim measure for homes that haven't yet transitioned—not as an accepted long-term solution to the IAQ impacts of gas stoves. Expanding gas infrastructure—and forcing affected households to pay for it—undermines progress toward healthier, cleaner homes.

1.2. Natural gas, outdoor air, and health

While space and water heating appliances can impact indoor air quality, a majority of their emissions may be vented to the outdoor air where they impact outdoor air quality[55].

Induction stoves are shown to reduce outdoor emissions compared to gas stoves, with one 2025 study finding reductions in outdoor VOC [27.3%], OFP [23.6%], PM2.5 [26.8%], CH4 [63.3%], CO2 [100%], and CO [94.4%] emissions for induction stoves compared to gas. The study found that induction stoves, compared to gas, can create an 11.4% total reduction in carbon emissions when considering both the indirect (energy usage) and direct (localized outdoor) emissions[56].

The outdoor air quality impacts of residential gas appliances also cause significant damage to human health. In 2020, Zhu et al. found that replacing all residential gas appliances with electric would create a reduction of outdoor NOX and $PM_{2.5}$ alone significant enough to prevent 354 deaths, 596 acute bronchitis cases, 305 chronic bronchitis cases, and $3.5 billion in public health costs annually in California alone. This doesn't even account for indoor air quality improvements from switching to electric, which would increase this benefit.

II. From Our Homes to Our Health: Indoor Air Quality Community Project

1.1 Introduction and Purpose

Between 2024 and 2025, Comunidades Organizando el Poder y la Acción Latina (COPAL) and Ayada Leads, in partnership with Fresh Energy, carried out a community-based indoor air quality study focused on homes located in Minnesota's environmental justice communities. The project sought to assess the effects of gas stove usage on indoor air pollution, measure actual pollutant levels, and capture residents' lived experiences. Its goal was to produce data that can inform public health policies, support equitable clean energy transitions for vulnerable populations, and raise

[55] Mullen et al 2016

[56] Yang, J., Guan, J., Zhang, X., Chen, S., Guo, Y., Yuan, H., Dai, J., Xu, Q., Zhang, G., Li, Y., Lin, Z., Wu, Y., & Yang, C. (2025). Pollutant emissions and environmental advantages of heating peanut oil by using commercial induction cooktop: A comparative analysis with traditional natural gas stoves. *Environmental Pollution*, 366, 125457.

awareness through education within frontline communities on issues that are often overlooked.[57]

1.1.1 Equipment and Monitoring Process

The study utilized the uHoo indoor air quality monitor, a smart device capable of continuously measuring multiple pollutants, including nitrogen dioxide (NO_2), carbon monoxide (CO), carbon dioxide (CO_2), volatile organic compounds (VOCs), and particulate matter.

1.1.2 COPAL Process Details

The device was placed at breathing height in participant kitchens, at least two feet away from gas stoves, to capture accurate air quality data during typical cooking activities. Monitoring was conducted in three Latino/e homes (COPAL member's name listed below) sequentially over a total period of approximately eight weeks, with each household hosting the device for 19 to 21 days. Participants maintained activity logs detailing cooking times, window use, and other relevant factors, while the Environmental Justice (EJ) team provided ongoing support for troubleshooting, documentation, and interviews.[58]

List of Participants & Recorded Project Dates:

- Dulce De La Rosa (*Nov 19, 2024 – Dec 10, 2024)*
- Wendy Zuniga (*Dec 11, 2024 – Dec 26, 2024)*
- Francisco Segovia *(Jan 13, 2025 – Feb17, 2025)*

1.1.3 Ayada Leads Process Details

Ayada Leads conducted an indoor air quality study focusing on five families from African diaspora communities across the Twin Cities living in apartments and single-family homes with gas stoves. Participants were provided with a portable induction cooktop and induction-safe cookware to encourage alternative cooking methods.

The study involved placing a uHoo air quality monitor in each home for two weeks: the first week, participants cooked as usual while logging stove use, and the second week, they implemented pollution-reducing strategies such as using electric appliances and improving ventilation by opening windows. Compliance varied among

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[57] Andrew Hazzard, "How Bad Are Gas Stoves for Your Health? Some Minnesota Families Get Real-Time Data," Sahan Journal, February 6, 2025, https://sahanjournal.com/climate-environment/minnesota-gas-stove-health-risk-solutions/.

[58] COPAL & Ayada Leads Indoor Air Quality Project (2024): *Preliminary data collected from homes in environmental justice communities in Minnesota show elevated indoor air pollutant levels in households with gas stoves and heating appliances.* uHoo Air Monitor - Indoor Pollution Test Proposal - Google Docs

households, and some homes had venting systems while others did not. Engagement was community-centered, relying on one-on-one conversations using plain language to build trust and provide practical support.[59]

1.2 Key Findings and Insights

The monitoring revealed consistently elevated indoor concentrations of NO_2, CO, CO_2, and VOCs during cooking with gas stoves, with pollutant levels peaking during meal preparation times. These indoor pollutant levels frequently exceeded the highest recorded outdoor pollution in the region, including measurements near busy highways and industrial sites.

1.2.1 COPAL Findings

In many homes, pollutant concentrations exceeded the highest outdoor readings reported by the Minnesota Pollution Control Agency (e.g., higher than next to Interstate-35 or near the Flint Hills oil refinery).

Residents reported respiratory symptoms such as coughing, wheezing, and asthma exacerbations that correlated with these pollution spikes. Additionally, there was a general lack of awareness among participants regarding the health risks posed by gas appliances, compounded by cultural and educational barriers. Anonymized participant testimonies highlighted the real-world health impacts and systemic challenges faced, emphasizing the need for equitable policies and alternatives to gas cooking in environmental justice communities[60]. Charts for each house presenting data on the pollutants measured: nitrogen dioxide (NO_2), carbon monoxide (CO), carbon dioxide (CO_2), volatile organic compounds (VOCs), and particulate matter can be found in this source.

1.2.2 Ayada Leads Findings

The Ayada Leads indoor air quality study demonstrated that small, accessible changes—such as using portable induction cooktops and improving kitchen ventilation—can lead to measurable improvements in air quality and health outcomes, particularly in environmental justice communities. All participants learned for the first time that gas stoves contribute to indoor air pollution.[61]

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[59] COPAL & Ayada Leads Indoor Air Quality Project (2024) Ayada Leads' AQM stories - Google Docs
[60] COPAL & Ayada Leads Indoor Air Quality Project (2024): *Preliminary data collected from homes in environmental justice communities in Minnesota show elevated indoor air pollutant levels in households with gas stoves and heating appliances.*
[61]COPAL & Ayada Leads Indoor Air Quality Project (2024) Ayada Leads' AQM stories - Google Docs

III. Community Testimonies and Lived Experience Based on Indoor Air Quality Project.

We include testimonies from participants in our air quality project that highlight the everyday challenges of living with gas appliances: asthma flare-ups, hospital visits, lack of options to switch to electric, and feelings of being "locked in" to unhealthy systems. These stories are not just anecdotal; they represent the real-world consequences of policy decisions made without full public participation or justice-centered frameworks. We urge the Commission to treat these voices with the same weight as technical and economic analyses. We respectfully request that these statements be shared directly with the Commissioners, as several are addressed to them personally by members of our communities.

1.1 Ayada Leads Testimonies

In Brooklyn Park, **Ayan's family** began consistently using their ducted vent, which had previously gone unused. "These small changes make a difference," Ayan shared. Her mother, Nimco—a refugee from Somalia—was initially skeptical of electric cooking, saying, "It doesn't cook the same," but she has since expressed interest in switching to an electric stove in the future.

Alia, living in a Minneapolis apartment with her sister, praised the renter-friendly induction cooktop. "It boiled water so fast," she noted, highlighting how the simplicity and effectiveness of electric cooking increased their confidence in making healthier choices.

Mary, a St. Paul resident with asthma, reported noticeable differences during the week she avoided her gas stove: "I noticed a difference in my asthma symptoms," she said. Her apartment lacked a kitchen vent but had a window, which she used for additional ventilation.

These testimonies illustrate not only the health impacts of gas stove use but also the importance of culturally relevant outreach and practical alternatives for renters and homeowners alike. Ayada Leads plans to hold a community event to share study results and continue education on indoor air quality.

1.2 COPAL Testimonies

1.1 **Breathing Shouldn't Be a Privilege:** *Dulce de La Rosa Testimony*

Every winter, when the cold starts, I already know what's coming: a sky-high gas bill. Sometimes it's $400 or $500 dollars—and that's not even counting rent and other basic living expenses. So when I hear they want to extend more gas lines and that we, the long-time customers, would be the ones paying for it, I have to ask: how much more can we take?

For families like mine, this just isn't fair. There are three of us in our home—my two teenage children and I, and we live on very limited means. The ones benefiting from these gas expansions are the big companies, not us. For them, a $500 bill means nothing. But for us, it pushes us further into poverty.

That's why, when I was offered the chance to participate in a project that involved installing an air quality monitor in my home, I said yes. I wanted to know what we were breathing. And honestly, the results didn't surprise me: pollution levels in my home were extremely high. It just so happened it was around Thanksgiving, and I had the oven on all day. But the truth is, I cook two or three times a day. And like many Mexican families, our food involves frying, chiles, and tortillas warmed on the griddle. That's our culture. But it also means lots of smoke, lots of pollutants… a lot of risk.

The contamination didn't shock me because I'm already used to it. But seeing the numbers made it real. And it hurt more because my kids and I have asthma. Respiratory attacks are part of our lives. I also have two little dogs, and in winter I often hear them coughing too. There's just no ventilation. The gas affects everyone in the home, including the pets.

After the study, I made some changes. I try to keep the windows open in the spring and summer. I've started thinking more about how to cook with less smoke. But it's not easy. And as much as I'd love to switch to an electric stove, I don't own the home—I rent. How am I supposed to make those changes when the space doesn't even belong to me?

I've also spoken with other homeowners who want to make changes but can't afford them. Where is the support? Are there funds? Payment plans? If the government or the utility companies truly care about public health, they should help families transition. Not just a few, but everyone. Every household should have an air quality monitor. It's our right to know what we're breathing.

Before the study, I never even considered that the air in my home could be harming us. I always believed my home was the safest place to be. But now I see that when I cook in an enclosed space, several times a day, the harm is happening right there. And as painful as it is, I've had to start letting go of some traditions to protect my family's health.

As a community health promoter and volunteer, I didn't keep this experience to myself. I've shared it with others. Because this—more than anything—is about education. And in the Latino community, we lack access to that education. Many homes don't even have kitchen vents or fans. Some don't have windows that stay open. We don't live this way by choice—it's what we can afford. And that should not mean we must sacrifice our health.

If I could speak directly to the Public Utilities Commission, this is what I'd say:

We don't deserve to keep paying for more harm. We're already paying enough—not just with money, but with our health. The big companies should be the ones covering those costs, not the families barely getting by. This is a chance to be more human—to prioritize people's health and lives, to create resources that help us make real change. We're not asking for luxuries. We just want clean air to breathe.

Because breathing should never be a privilege.[62]

1.2 Breathing Comes at a Cost: *Wendy Segovia Testimony*

When I first joined the air quality monitor study, I thought it would just be interesting. But it turned out to be eye-opening. I became more aware—more conscious—of what we breathe inside our own homes. The results were concerning. I started to ask myself: Why aren't we talking about this more often? Why aren't we doing something about it?

We're talking about the air, something you don't see, don't think about every day, but you breathe it constantly. And if you can avoid breathing toxic or carcinogenic air, why wouldn't you? The study showed me that the air in my house isn't as safe as I thought. And that's deeply unsettling, especially when you have family living with you. I think about my kid,

[62] Testimonies, COPAL Project Participants_Original (2025). https://drive.google.com/drive/folders/1HOzinvs2NasTWiHaHa7uXuar1NN7uCdC?usp=drive_link

the elderly, future generations, and how much they'll carry the burden if nothing changes.

Now, when I hear about utility companies wanting to build more gas line extensions, I can't help but feel we're going backward. These new lines would bring gas to new customers, but the cost? It would fall on us, the existing customers, people who are already struggling to pay their gas and electric bills. And for what? More pollution? More health risks? It doesn't make sense.

I think those profiting from these projects, the companies themselves, should be the ones paying for it. They're the ones who will gain the most. Why should families like mine pay more to breathe worse air? And we don't even get a say. It's like when someone builds a sidewalk and just hands you the bill. You didn't ask for it, but now you owe it. That doesn't feel just.

The problem runs deeper than cost. It's about access. Even if someone wants to switch away from gas—because they care about their family's health—they often can't afford to. We see it all the time in our communities. People don't have the information, and even when they do, the alternatives are expensive. If we're serious about people's health, then we need to make it affordable to choose safer options. That means making air quality monitors accessible, helping families make changes in their homes, and supporting people with real, meaningful policy.

This is not just about individual choices. It's about systems. We need systemic solutions. We need the government and utilities to invest not in expanding gas, but in clean, healthy infrastructure. This is about investing in our future. In our children. In our elders. In everyone who deserves to live without being slowly poisoned in their own kitchen.

In the Latinx community, especially, the language and tools around air quality are just not accessible. The science is complex, the resources are limited, and no one is coming into our neighborhoods to explain these things or offer help. But that doesn't mean we don't care. It means we need support. Outreach. Investment. It's cheaper to invest in prevention now than to pay the price later in asthma, cancer, and emergency room visits. But people don't see that—because they can't measure what they breathe. You don't know until you get sick. And by then, it's too late.

So if I could say something directly to the **Public Utilities Commission**, I would say this:

You carry a **huge responsibility**. The health of our communities depends on the decisions you make. You must protect the public. You must make sure policies are in place that ensure people can access clean, safe air. You must regulate companies that profit from polluting our homes. You must create systems that prioritize health, equity, and the long-term well-being of our families, not corporate profits.

Because breathing shouldn't come at the cost of our health. And protecting life should never be optional.[63]

1.3 Living with Gas in an Old Home: *Francisco Segovia Testimony*

We live in a house built in 1925. It's small, with closed-off spaces, and the kitchen in particular is very compact. It wasn't until we installed an air quality monitor that we truly began to notice what had always seemed normal: the heat that builds up when we cook, the lack of ventilation, and how the old design of the house doesn't allow for good airflow. All of this began to take on a new meaning. For a long time, we've kept the home's ventilation system running year-round, just to circulate air. We change the filters every six months, and I'm always surprised by how dirty they get. We do it mainly because my wife has asthma. We don't know exactly when she developed it, but it's part of our life now. Her asthma wasn't caused by gas, but using gas in a poorly ventilated house becomes a real concern.

I remember one day I had to rush her to the emergency room because she couldn't breathe. She takes many precautions—she always carries epipens and medical devices. She's had severe allergic reactions to food and even to smells. One day, she bought some eucalyptus leaves to help filter the air, but later she began to suspect the smell was affecting her, too.

We cook a lot at home. I make breakfast six days a week, especially for our son, and in the evenings, my wife and I take turns. Our gas stove is about eight years old—not that old—but we've thought about replacing it. The problem is the cost. I already switched the gas dryer to electric, and that alone cost me $1,000 just for the electric line. For the stove, an electrician told me the line alone would cost $1,500—plus the cost of a new stove. We're talking over $2,500. And for a family like ours, with limited resources, that's no small expense. There are four of us at home: my wife, my son, a cousin, and I.

We also have a gas fireplace that we use in the winter. It used to be wood-burning, but we converted it because it was more practical. But of course, that's more gas in a home that already struggles with ventilation.

During the two weeks we had the air quality monitor, we realized the readings were high, especially in the kitchen. That raised a lot of questions: What's causing those levels? Is it just the gas, or also the lack of airflow? For example, our range hood doesn't vent outside—it just recirculates the air. And we learned that this type of system doesn't really help much.

That experience made us seriously consider remodeling the kitchen. We were going to do it this year, but we decided to wait. But beyond the remodel, the most

[63] Testimonies, COPAL Project Participants_Original (2025). https://drive.google.com/drive/folders/1HOzinvs2NasTWiHaHa7uXuar1NN7uCdC?usp=drive_link

important realization was the impact on health. If gas is contributing to making my wife's asthma worse, then it becomes an urgent issue. And health can't be put off.

When we talk about who should pay for these changes—like upgrading electric lines—I think it's unfair to put that burden on families. The big gas companies want to keep expanding, but the costs are falling on us, the consumers. Meanwhile, CEOs are making millions. I believe some of these services should be publicly owned, not run by private companies, because they're collective goods.

Also, the study we did in our home made me think about the need to expand this kind of monitoring to more households, especially in vulnerable communities like ours. Many times, we don't realize what's entering our homes or the impact it can have. I remember a study from the Children's Hospital in the Phillips neighborhood that identified 3,000 children with asthma. Many of them lived in basements or poorly ventilated homes like mine. And that's a public health problem.

The Public Utilities Commission should take all of this into account. It's not just about numbers or profits—it's about the well-being of communities. Because if we keep ignoring the health impacts of gas, we'll continue raising generations of kids with respiratory illnesses. And that carries a huge human and economic cost. That's why I believe we need to make sure this information reaches people. Only then can they make informed decisions. Our social commitment is to advocate for public policies that recognize this reality: that many families simply cannot make these changes without support. Because when you have to choose between buying food or replacing a stove, the decision is obvious. And it shouldn't be that way.[64]

CONCLUSION

The continuation of subsidized gas line extension allowances directly contradicts Minnesota's legally mandated climate commitments and jeopardizes the health, economic well-being, and equitable treatment of the state's most vulnerable communities. Our collective experience and research demonstrate that these policies perpetuate unjust financial burdens on existing ratepayers, disproportionately low-income and BIPOC households, while enabling the expansion of fossil gas infrastructure at a time when the urgent imperative is to phase it out.

By obscuring the true costs of gas infrastructure expansion and socializing those costs across all customers, these allowances lock Minnesota into decades of harmful emissions, escalating health risks, and mounting financial liabilities. This not only undermines the state's goals to reduce greenhouse gas emissions by 50% by 2030 and

[64]Testimonies, COPAL Project Participants_Original (2025). https://drive.google.com/drive/folders/1HOzinvs2NasTWiHaHa7uXuar1NN7uCdC?usp=drive_link

achieve net-zero by 2050 but also contradicts ongoing efforts to prioritize electrification, energy efficiency, and equitable access to clean energy solutions.

Importantly, the inequities embedded in current gas line extension policies exacerbate existing disparities, as shown by testimonies. Low-income families and frontline communities already face disproportionate energy insecurity, higher energy bills, and elevated health risks from fossil fuel pollution. Meanwhile, subsidies often benefit developers in more affluent areas, leaving underserved communities behind in the energy transition and locked into expensive, unhealthy fossil fuel dependence.

Reforming these policies by eliminating free footage allowances, requiring utilities to internalize the full lifecycle costs of new gas connections, and redirecting subsidies toward equitable electrification programs is not only necessary—it is urgent. Doing so will protect Minnesota families from rising energy costs, reduce climate and health harms, prevent stranded assets, and ensure a just transition that leaves no community behind.

The Commission's current inquiry offers a unique opportunity to align Minnesota's gas infrastructure policies with its climate mandates and social justice commitments. We urge a decisive shift away from subsidizing fossil fuel expansion and toward investments that prioritize affordability, equity, and public health, building a clean energy future that works for all Minnesotans.

Organizational Signatories

The following organizations respectfully submit and support these comments in response to the Commission's request for input in Docket No. [G999/CI-21-565]:

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RESOURCES

Bédard MA, et al. Association between gas stove use and childhood asthma in the Canadian CHILD Cohort Study. Can J Public Health. 2023 Aug;114(4):705-708.
Relative risk (RR) of gas stove use (compared to electric stoves) on preschool asthma was determined. Children in households with gas stoves at three months had a higher risk of asthma

at three years. In site-specific analyses, risk of five-year asthma was doubled in gas stove households in Toronto but not Vancouver, two urban cities with extremely different climates.

COPAL & Ayada Leads Indoor Air Quality Project (2024): *Preliminary data collected from homes in environmental justice communities in Minnesota show elevated indoor air pollutant levels in households with gas stoves and heating appliances.*

Testimonies, COPAL Project Participants_Original (2025). https://drive.google.com/drive/folders/1HOzinvs2NasTWiHaHa7uXuar1NN7uCdC?usp=drive_link

Briggs, B., Gross, N., Hall, M., Hobgood, T., Orozco, A., Paredes, L., Pennington, R., Phoenix, J., Rodeffer, M., Shriner, M., Tulkin, J., Vilmenay, R., Argueta, A. Bah, D., Clausen, P., Cohen-Shields, N., Estes, L., Hall, G., Moussa Harouna, A., Joya, L., Long, J., Meyer, K., Morales, M., Novey, J., Overby, J., Rondon, E., Siddiqui, S., Spencer, C., Lucia Vasquez., M, Wood, S., Yango, S. (2024). Cooking Up Danger: Community Study Reveals Hazardous Nitrogen Dioxide Levels in DC and Maryland Kitchens.
Beyond Gas Maryland
In tests of 663 Maryland and DC kitchens, 63% exceeded the EPA's 1-hour NO_2 exposure standard (100 ppb). Average peak levels were 1.68x the exposure standard. Testing involved 30 minutes of stove use (either oven + 2 burners or 4 burners without oven), with NO_2 measured during and after operation.

Buonanno, G , Morawska, L & Stabile, L (2009). Particle emission factors during cooking activities. Atmos. Environ. 43, 32353242
Found particle emission factors to be lower for electric stoves, and higher for gas stoves.

Dennekamp, M et al. (2001). Ultrafine particles and nitrogen oxides generated by gas and electric cooking. Occup. Environ. Med. 58, 511–516
This study measured ultrafine particles (<100 nm) and nitrogen oxides (NOx) produced by gas and electric cooking. Gas combustion, frying, and cooking fatty foods generated high particle concentrations, especially ultrafine particles sized 15–40 nm. Gas cooking also produced high peaks of nitrogen dioxide and nitric oxide. Poor kitchen ventilation can lead to toxic exposures to these pollutants, which may harm respiratory and possibly cardiac health, highlighting the need for further research.

Chan, W., Kim, Y.-, Less, B., Singer, B., & Walker, I. (2019). Ventilation and Indoor Air Quality in New California Homes with Gas Appliances and Mechanical Ventilation
Lawrence Berkeley National Laboratory
Focused on ventilation as a solution to mitigate health impacts of poor indoor air quality from gas appliances. Acknowledges energy efficiency issues with air leakage.

Chua, S. Y. L., Warwick, A., Peto, T., Balaskas, K., Moore, A. T., Reisman, C., Desai, P., Lotery, A. J., Dhillon, B., Khaw, P. T., Owen, C. G., Khawaja, A. P., Foster, P. J., & Patel, P. J. (2022). Association of ambient air pollution with age-related macular degeneration and retinal thickness in UK Biobank. British Journal of Ophthalmology, 106(5), 705–711.
In addition to impacts to respiratory health, these pollutants harm eye health. One 2022 study found high PM2.5 levels to be associated with higher incidence of self-reported age-related macular degeneration, and "PM2.5, PM2.5 absorbance, PM10, NO2, and NOx" to be "associated with differences in retinal layer thickness."

Cyrys, J., Heinrich, J., Richter, K., Wölke, G., & Wichmann, H. E. (2000). Sources and concentrations of indoor nitrogen dioxide in Hamburg (west Germany) and Erfurt (east Germany). The Science of the Total Environment, 250(1–3), 51–62.
Found that gas cooking was the strongest predictor "of indoor NO_2 concentrations", associated with a 41% increase in indoor NO_2 levels.

Daouda, S. (2024). Out of Gas, In with Justice: Findings from a Gas-to-Induction Pilot in Low-Income Housing in NYC.
Energy Research & Social Science, 116.
Examines the impacts of transitioning from gas to induction stoves in low-income housing, highlighting improvements in air quality, resident satisfaction, and health outcomes. This included a 56% reduction in average NO2 concentration for induction stoves compared to gas stoves, along with a decrease in CO levels, and a "non-significant increase in daily averages of PM2.5 concentration in the induction arm."

Eghomwanre, A. F., & Oguntoke, O. (2022). Concentrations of indoor gaseous air pollutants and risk factors associated with childhood asthma in Benin City, Nigeria.
Environmental Monitoring and Assessment, 194(5), 391.
Found household CO (but not SO2 or NO2) levels to be associated with increased asthma prevalence in children. In addition, the number of people living in the household and proximity to a highway contributed to childhood asthma. Crowdedness was the strongest predictor of asthma (even stronger than family history), with children living in overcrowded households having 12x the rate of asthma compared to those in uncrowded homes.

Fabian, M. P., Adamkiewicz, G., Stout, N. K., Sandel, M., & Levy, J. I. (2014). A simulation model of building intervention impacts on indoor environmental quality, pediatric asthma, and costs. Journal of Allergy and Clinical Immunology, 133(1), 77–84.
Compares effectiveness of several interventions in reducing childhood asthma serious events and symptom days, and associated health costs. The interventions include fixing fans, replacing gas stoves with clean alternatives, halting use of ovens for heating, stopping smoking, implementing HEPA filters, integrated pest management, and weatherization. "The highest savings in health care use were associated with IPM, fixing exhaust fans, and replacing the gas stove, and the intervention with the highest cost was weatherization without any other intervention… Interventions…led to 7% to 12% reductions in serious asthma events with 1- to 3-year payback

periods. Weatherization efforts targeted solely toward tightening a building envelope led to 20% more serious asthma events, but bundling with repairing kitchen exhaust fans and eliminating indoor sources (eg, gas stoves or smokers) mitigated this effect."

Figueroa, L. A., & Lienke, J. (2022). The Emissions in the Kitchen: How the Consumer Product Safety Commission Can Address the Risks of Indoor Air Pollution from Gas Stoves. Institute for Policy Integrity.
Gas stoves emit dangerous levels of indoor air pollutants like nitrogen dioxide (NO_2) and fine particulate matter ($PM_{2.5}$), posing serious health risks—especially to children and vulnerable groups. The report recommends that the Consumer Product Safety Commission (CPSC) address these risks by setting performance standards, requiring warning labels, and launching public awareness campaigns.

Fortmann, R , Kariher, P & Clayton, R. (2001). Indoor air quality: Residential cooking exposures.
This large-scale study measured indoor air pollution from typical cooking activities in a residential test house. Cooking—especially with gas stoves—was shown to produce high levels of harmful pollutants like fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO), formaldehyde, and polycyclic aromatic hydrocarbons (PAHs). $PM_{2.5}$ levels during some cooking activities exceeded 1,000 $\mu g/m^3$, and NO_2 exceeded health guidelines. The highest emissions occurred during gas oven cleaning. The study confirms cooking as a major source of indoor air pollution and highlights the need for further research and exposure reduction strategies.

Gaffin, J. M., Hauptman, M., Petty, C. R., Sheehan, W. J., Lai, P. S., Wolfson, J. M., Gold, D. R., Coull, B. A., Koutrakis, P., & Phipatanakul, W. (2018). Nitrogen dioxide exposure in school classrooms of inner-city children with asthma. Journal of Allergy and Clinical Immunology, 141(6), 2249-2255.e2.
"NO2 levels were associated highly with airflow obstruction," but not "with percent predicted FEV1, fraction of exhaled nitric oxide, or asthma symptoms."

Garg A, et al. (2025). Exposure and health risks of benzene from combustion by gas stoves: A modelling approach in U.S. homes. J Hazard Mater. ;492:137986.
This study evaluates population-level benzene exposure and associated health risks for the 6.3 million U.S. residents exposed to the top 5 % highest benzene-emitting gas stoves. The results show that gas stove emissions significantly elevate cancer risks in homes with medium to high gas stove usage and inadequate ventilation.

Garrett, M H , Hooper, M A , Hooper, B M & Abramson, M J. (1998). Respiratory Symptoms in Children and Indoor Exposure to Nitrogen Dioxide and Gas Stoves Am. J. Respir. Crit. Care Med. 158, 891–895
Found that in a sample of 148 children, "nitrogen dioxide exposure was a marginal risk factor for respiratory symptoms, with a dose–response association present… Gas stove exposure was a significant risk factor for respiratory symptoms even after adjusting for nitrogen dioxide

levels…suggesting an additional risk apart from the average nitrogen dioxide exposure associated with gas stove use.

Gruenwald, T., Seals, B., Knibbs, L., Hosgood, D. (2022). Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States. International Journal of Environmental Research and Public Health.
Estimates that gas stove use is responsible for 12.7% of childhood asthma nationwide, with disproportionate impacts on communities of color and low-income families.

Han YY, Rosser F, Forno E, Acosta-Pérez E, Canino G, Celedón JC. (2023) Gas stove use and asthma in a longitudinal study of Puerto Rican children and adolescents. J Allergy Clin Immunol Pract. (8):2599-2601.e3.
This is reported to be the first prospective study of gas stove use and asthma in Puerto Rican youth, a high-risk group. "Participants reporting gas stove use at two follow up visits had 2.45 times significantly higher odds of asthma than those reporting electric stove use at both visits."

Jiao X, et al. (2025). Significant Cross-Contamination Caused by Cooking Fume Transport between Dwelling Units in Multilayer Buildings. Environ Sci Technol.;59(19):9665-9675.
The authors conducted a 2-month monitoring campaign in a multilayer residential building, identifying 53 interunit kitchen exhaust transmission events (~2 per day), causing enhanced exposure of particulate matters (PM), black carbon (BC), NOx, and CO and volatile organic compounds (VOCs) in both the kitchen and living room. These events resulted in a 40−80% increase in PM deposition in the respiratory systems for occupants in the living room, especially fine particles depositing in the alveolar region. Evidence indicates that these pollutant events originated from cooking fume transport.

Kang, C.M. (2023). Impacts of Residential Indoor Air Quality and Environmental Risk Factors on Adult Asthma-Related Health Outcomes in Chicago, IL.
Journal of Exposure Science & Environmental Epidemiology, 33.
Links indoor NO_2 levels in Chicago homes to worsened asthma outcomes in adults, particularly in under-resourced neighborhoods.

Kashtan YS, et al. (2023) Gas and Propane Combustion from Stoves Emits Benzene and Increases Indoor Air Pollution. Environ Sci Technol. 57(26):9653-9663.
Across 87 homes in California and Colorado, natural gas and propane combustion emitted detectable and repeatable levels of benzene that in some homes raised indoor benzene concentrations above well-established health benchmarks. Neither induction stoves nor the food being cooked emitted detectable benzene.

Kornartit, C., Sokhi, R. S., Burton, M. A., & Ravindra, K. (2010). Activity pattern and personal exposure to nitrogen dioxide in indoor and outdoor microenvironments. Environment International, 36(1), 36–45.

Found that in wintertime, "the average NO_2 levels in kitchens with a gas cooker were twice as high as those with an electric cooker."

Lebel, E.D., Finnegan, C.J., Ouyang, Z., & Jackson, R.B. (2022). Methane and NO_x Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes. Environmental Science & Technology.
Quantifies emissions from gas cooking appliances, demonstrating that even when turned off, stoves leak high levels of methane and NO_x,, contributing to climate change and indoor air pollution.

Lee, K., Xue, J., Geyh, A. S., Ozkaynak, H., Leaderer, B. P., Weschler, C. J., & Spengler, J. D. (2002). Nitrous acid, nitrogen dioxide, and ozone concentrations in residential environments. Environmental Health Perspectives, 110(2), 145–150.
Found presence of a humidifier and an air conditioner (appliances that are often inaccessible to lower-income families) to be significant predictors of lower indoor HONO levels. Found that "presence of a gas range" was "significantly associated with indoor NO2 and HONO concentrations."

Lin, W., Brunekreef, B., & Gehring, U. (2013). Meta-analysis of the effects of indoor nitrogen dioxide and gas cooking on asthma and wheeze in children. International Journal of Epidemiology, 42(6), 1724–1737.
A 2013 meta-analysis of 41 studies. Found gas cooking to increase asthma risks, and indoor NO2 to increase wheeze risk, in children. Specifically, this study found that "children living in a home with gas cooking have a 42% increased risk of having current asthma," and that "per 15 ppb increase in indoor NO2 level, children have a 15% increased risk of having current wheeze."

Lobscheid, A. B., Klepeis, N. E., & Singer, B. C. (2011). Modeling Population Exposures to Pollutants Emitted from Natural Gas Cooking Burners.
Found that about 40% of Southern California homes had at least one instance in a week where the peak 1-hour indoor NO2 level exceeded the "US EPA NO2 standard" How often this occurred was "related primarily to building volume, emission rate, and amount of burner use" and was "largely independent of" air exchange rate "assumption.""slightly more than 5%" of these households "exceed the 8-hr CO standard (9 ppm) at least once over the course of the week."

Logue, J. M., Klepeis, N. E., Lobscheid, A. B., & Singer, B. C. (2014). Pollutant Exposures from Natural Gas Cooking Burners: A Simulation-Based Assessment for Southern California. Environmental Health Perspectives, 122(1), 43–50.
This study modeled indoor pollution from natural gas cooking burners (NGCBs) in Southern California. It found many homes had nitrogen dioxide, carbon monoxide, and formaldehyde levels above health standards, especially without venting range hoods. Using range hoods can greatly reduce these exposures, making it important for improving indoor air quality.

Logue, J M , McKone, T E , Sherman, M H & Singer, B C. (2011). Hazard assessment of chemical air contaminants measured in residences Indoor Air 21, 92–109 (2011)
This study reviewed data from 77 studies measuring chemical pollutants in U.S. homes and similar countries. It identified 15 pollutants frequently exceeding chronic health standards indoors, and nine additional pollutants posing risks in fewer homes. Nine chemicals—including formaldehyde, benzene, nitrogen dioxide, and PM2.5—were prioritized as key indoor hazards. The study also highlighted that common household activities can cause acute exposure to certain pollutants. These findings help prioritize indoor air quality risk management and guide efforts to reduce harmful chemicals in homes.

Mullen NA, Li J, Russell ML, Spears M, Less BD, Singer BC. Results of the California Healthy Homes Indoor Air Quality Study of 2011-2013: impact of natural gas appliances on air pollutant concentrations. Indoor Air. (2):231-45.
Provides comprehensive data on pollutant levels (NO_2, CO, $PM_{2.5}$) from gas appliances in real-world housing, reinforcing the need for electrification in residential buildings. Found "NOX, NO2, and highest 1-h CO were higher in homes that cooked with gas and increased with amount of gas cooking." This study was conducted to assess the current impact of natural gas appliances on air quality in California homes. Passive samplers measured CO and NOX, NO2, formaldehyde, and acetaldehyde over ~6-day periods.

Nassikas NJ, et al. Indoor Air Sources of Outdoor Air Pollution: Health Consequences, Policy, and Recommendations: An Official American Thoracic Society Workshop Report. Ann Am Thorac Soc. 2024 Mar;21(3):365-376.
This American Thoracic Society workshop was convened in 2022 to evaluate this increasing proportion of indoor contributions to outdoor air quality. The exhaust from residential and commercial natural gas combustion is often vented directly outdoors, contributing to outdoor air pollution. Residential and commercial cooking are major sources of indoor air pollution that also contribute to outdoor air pollution.

Park, S. S., & Cho, S. Y. (2010). Performance Evaluation of an In Situ Nitrous Acid Measurement System and Continuous Measurement of Nitrous Acid in an Indoor Environment. Journal of the Air & Waste Management Association, 60(12), 1434–1442.
Found that in homes with gas stoves, NO and NO2 levels peaked immediately after turning off the gas range, and HONO "peaked 5-15 min after combustion had stopped." Found "HONO concentrations during the unvented combustion to be approximately 8 –10 times higher than background levels depending on the time of day."

Paulin, L. M., Williams, D. 'Ann L., Peng, R., Diette, G. B., McCormack, M. C., Breysse, P., & Hansel, N. N. (2017). 24-h Nitrogen dioxide concentration is associated with cooking behaviors and an increase in rescue medication use in children with asthma. Environmental Research, 159, 118–123.
Found that gas stove and oven use use increased household NO_2 levels. These increases in household NO2 levels weren't associated with lung function or asthma symptoms in children, but were "associated with increased nighttime inhaler use in children with asthma"

Seals, B., & Krasner, A. (2020). Health Effects from Gas Stove Pollution. Rocky Mountain Institute, Physicians for Social Responsibility, Mothers Out Front, and Sierra Club.

Spengler, J et al (1994) Personal Exposure to Nitrogen Dioxide in the Los Angeles Basin Air Waste J. Air Waste Manag. Assoc. 44, 39–47
This large-scale study monitored nitrogen dioxide (NO_2) exposure in 682 individuals across 482 households in the Los Angeles Basin over a one-year period. Using passive filter badges, researchers found that personal NO_2 exposure was higher in homes with gas stoves – especially those with pilot lights – compared to electric stoves. Median personal and outdoor NO_2 levels were both 35 ppb, while indoor levels were slightly lower at 24 ppb. The study showed that indoor levels strongly influenced personal exposure, with 59% of exposure variation explained by indoor concentrations and 48% by outdoor levels.

Underhill, L. J., Dols, W. S., Lee, S. K., Fabian, M. P., & Levy, J. I. (2020). Quantifying the impact of housing interventions on indoor air quality and energy consumption using coupled simulation models. Journal of Exposure Science & Environmental Epidemiology, 30(3), 436–447.
Highlights IAQ and energy efficiency tradeoffs of weatherization and ventilation interventions, and provides recommendations to balance these tradeoffs.

Underhill, L. J., Milando, C. W., Levy, J. I., Dols, W. S., Lee, S. K., & Fabian, M. P. (2019). Simulation of indoor and outdoor air quality and health impacts following installation of energy-efficient retrofits in a multifamily housing unit. Building and Environment, 170, 106507.
Highlights IAQ and energy efficiency tradeoffs of weatherization and ventilation interventions, and provides recommendations to balance these tradeoffs.

Upaphong, P., Thonusin, C., Wanichthanaolan, O., Chattipakorn, N., & Chattipakorn, S. C. (2024). Consequences of exposure to particulate matter on the ocular surface: Mechanistic insights from cellular mechanisms to epidemiological findings. Environmental Pollution, 345, 123488.
This 2024 comprehensive review linked PM exposure to "inflammatory responses, allergic reactions, oxidative stress, DNA damage, mitochondrial impairment," inhibited "proliferation and migration of ocular surface cells," "impaired wound healing," altered "tear composition," "ocular surface damage," "dry eye disease, blepharitis, conjunctivitis, keratitis, limbal stem cell deficiency and pterygium," along with worsened "preexisting ocular conditions."

US EPA. (2016). Basic Information about Carbon Monoxide (CO) Outdoor Air Pollution [Overviews and Factsheets].
Warns that CO can be lethal in enclosed spaces and can worsen the health impacts of heart disease, even through outdoor exposure.

Weller, ZD, Im S, Palacios V, Stuchiner E, von Fischer JC. Environmental Injustices of Leaks from Urban Natural Gas Distribution Systems: Patterns among and within 13 U.S. Metro Areas. Environ Sci Technol. 2022 Jun 21;56(12):8599-8609.
Across 13 metro areas combined, the authors found that natural gas distribution system leak densities increase with increasing percent of people of color and with decreasing median household income. These patterns of infrastructure injustice also existed within most metro areas, even after accounting for housing age and the spatial structure of the data.

Wi, C.-I., Gent, J. F., Bublitz, J. T., King, K. S., Ryu, E., Sorrentino, K., Plano, J., McKay, L., Porcher, J., Wheeler, P. H., Chiarella, S. E., DeWan, A. T., Godri Pollitt, K. J., Sheares, B. J., Leaderer, B., & Juhn, Y. J. (2023). Paired Indoor and Outdoor Nitrogen Dioxide Associated With Childhood Asthma Outcomes in a Mixed Rural-Urban Setting: A Feasibility Study. Journal of Primary Care & Community Health, 14, 21501319231173813.
Found indoor NO2 to be "significantly higher… in homes with gas versus electric stoves."

Wu, H., Ran, H., Dong, S., Li, L., Liu, J., Fan, W., Lu, D., Zhang, J., & An, J. (2025). Emission characteristics of indoor HONO from residential natural gas cooking stoves in a household in Kunming, China. Journal of Hazardous Materials, 494, 138661.
Found use of a gas stove to result in indoor NOx levels 120x the pre-combustion levels and HONO levels 36x their pre-combustion level. Explores alkaline cleaning, induction cookers, and range hoods as solutions, with induction cookers being the only solution with a 100% reduction potential.

Yang, J., Guan, J., Zhang, X., Chen, S., Guo, Y., Yuan, H., Dai, J., Xu, Q., Zhang, G., Li, Y., Lin, Z., Wu, Y., & Yang, C. (2025). Pollutant emissions and environmental advantages of heating peanut oil by using commercial induction cooktop: A comparative analysis with traditional natural gas stoves. Environmental Pollution, 366, 125457.
Focused on outdoor emissions, but also found that the "indoor breathing zone" for gas stoves had higher CH4 (Methane) and $PM_{2.5}$ levels compared to induction stoves. Found reductions in outdoor VOC [27.3%], OFP [23.6%], PM2.5 [26.8%], CH4 [63.3%], CO2 [100%], and CO [94.4%] emissions for induction stoves compared to gas. The study found that induction stoves, compared to gas, can create an 11.4% total reduction in carbon emissions when considering both the indirect (energy usage) and direct (localized outdoor) emissions.

Zhang, L.; Ou, C.; Magana-Arachchi, D.; Vithanage, M.; Vanka, K.S.; Palanisami, T.; Masakorala, K.; Wijesekara, H.; Yan, Y.; Bolan, N.; et al. (2021) Indoor Particulate Matter in Urban Households: Sources, Pathways, Characteristics, Health Effects, and Exposure Mitigation. Int. J. Environ. Res. Public. Health, 18, 11055.
This review highlights the growing health risks of indoor particulate matter (PM), which can originate from both outdoor sources and indoor activities like cooking, smoking, and heating. Indoor PM often contains harmful substances such as heavy metals and carcinogenic compounds and can reach higher concentrations than outdoor air. Since people spend most of their time indoors, exposure to indoor PM poses serious health concerns – especially for respiratory and

cardiovascular systems. The review also discusses key sources, health effects, and strategies to mitigate indoor PM exposure.

Zhang, Q., Gangupomu, R. H., Ramirez, D., & Zhu, Y. (2010). Measurement of Ultrafine Particles and Other Air Pollutants Emitted by Cooking Activities. International Journal of Environmental Research and Public Health, 7(4), 1744–1759.
Found that gas stoves emitted higher concentrations of UFPs, Black Carbon (BC), and $PM_{2.5,}$ compared to electric ones, and that "stove type had the most significant effect on all the variables analyzed."

Zheng, X., Ding, H., Jiang, L., Chen, S., Zheng, J., Qiu, M., Zhou, Y., Chen, Q., & Guan, W. (2015). Association between Air Pollutants and Asthma Emergency Room Visits and Hospital Admissions in Time Series Studies: A Systematic Review and Meta-Analysis. PLOS ONE, 10(9), e0138146.
Meta-analysis of 87 studies: found association between short-term PM_{10}, $PM_{2.5}$, NO_2, O_3, CO, and SO_2, exposure and higher risk of ED visits and hospitalization for asthma.

Zhu, Y., Connolly, R., Matthew, T., & Wang, Z. (2020). Effects of Residential Gas Appliances on Indoor and Outdoor Air Quality and Public Health in California. UCLA Fielding School of Public Health.
Found that when using a gas stove and oven together "for 1-hour," NO2 levels exceed acute national and CAAQ (California) standards 90% of the time. Found that indoor air pollution levels from gas appliances are higher for smaller units, like apartments. This study also outlined equity implications. Separately, found that replacing all residential gas appliances with electric would create a reduction of outdoor NOX and $PM_{2.5}$ alone (not accounting for indoor air quality improvements, which would increase this benefit) significant enough to prevent 354 deaths, 596 "cases of acute bronchitis, and 304…cases of chronic bronchitis annually in California… equivalent to approximately $3.5 billion in monetized health benefits over the course of one year."