

2022

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# **GAS APPLIANCES AND SMOG: CALIFORNIA'S HIDDEN AIR POLLUTION PROBLEM**

HOW STATE AND REGIONAL  
AIR AGENCIES CAN END  
APPLIANCE POLLUTION IN  
CALIFORNIA WITH ZERO  
EMISSIONS STANDARDS  
AND COMPLEMENTARY  
POLICIES



### Lead Authors:

Laura Feinstein, Sustainability and Resilience Policy Director, SPUR

Leah Louis-Prescott, Senior Associate, RMI

Monica Embrey, Senior Associate Director of Energy Campaigns,  
Sierra Club

### Reviewers:

Building Decarbonization Coalition

Emerald Cities Collaborative

### About RMI:

RMI is an independent nonprofit founded in 1982 that transforms global energy systems through market-driven solutions to align with a 1.5°C future and secure a clean, prosperous, zero-carbon future for all. We work in the world's most critical geographies and engage businesses, policymakers, communities, and NGOs to identify and scale energy system interventions that will cut greenhouse gas emissions at least 50 percent by 2030. RMI has offices in Basalt and Boulder, Colorado; New York City; Oakland, California; Washington, D.C.; and Beijing.

### About SPUR:

SPUR is a nonprofit public policy organization. We bring people together from across the political spectrum to develop solutions to the big problems cities face. Based in San Francisco, San José and Oakland, we are recognized as a leading civic planning organization and respected for our independent and holistic approach to urban issues. Through research, education and advocacy, SPUR works to create an equitable, sustainable and prosperous region.

### About Sierra Club:

The Sierra Club is America's largest and most influential grassroots environmental organization, with millions of members and supporters. In addition to protecting every person's right to get outdoors and access the healing power of nature, the Sierra Club works to promote clean energy, safeguard the health of our communities, protect wildlife, and preserve our remaining wild places through grassroots activism, public education, lobbying, and legal action.

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## Executive Summary

Gas appliances in homes and buildings are an underappreciated driver of unhealthy air quality in California cities — generating roughly four times as much lung-damaging nitrogen oxide (NOx) pollution as all of California’s electric utilities, and roughly two-thirds as much NOx as all of the state’s light-duty passenger cars. <sup>1</sup>

The pollution burden from gas appliances continues to be substantial relative to other sources of NOx, due in large part to decades of little to no action by regional, state, and federal air quality regulators. While effective pollution controls have succeeded in cutting NOx pollution from power plants 87% since 1995 nationwide, there has been no comparable statewide effort to slash pollution from residential and commercial gas combustion. <sup>2</sup>

Californians – and especially low-income Californians and communities of color – have paid the price for this inaction through decades of dirtier air quality. NOx pollution reacts with volatile organic compounds (VOC) in the presence of heat and sunlight to form ozone – the major component of smog. Ozone pollution is so severe across California that a majority of air districts fail, year after year, to meet legally mandated federal air quality standards that protect health. More than half of all Californians live in areas that exceed the most stringent 70 ppb ozone standard — and 99% of disadvantaged communities in California live in an ozone nonattainment area. <sup>3</sup> An estimated 13,700 Californians died in 2012 because of long-term ozone exposure. <sup>4</sup>

The state and regional air districts tasked under the Clean Air Act with bringing California into compliance with federal air quality standards “as expeditiously as practicable” have a legal responsibility to take stronger action to tackle NOx pollution from gas appliances – an obligation that is all the more clear given that the technology solution for tackling this NOx pollution – the electric heat pump – is readily available.

Heat pumps are highly efficient zero-emission electric technology that can be used for water heating, and for warming and cooling buildings. Air source heat pumps provide both heating and air conditioning in a single device, while delivering key climate, health, and resilience co-benefits. In addition to cutting NOx pollution, an equitable transition to electric heat pumps in homes could advance housing and environmental justice by making homes healthier, safer, and more affordable for households by improving indoor air quality, cutting energy use, and increasing access to cooling in the face of climate-fueled heat waves.

This year, for the first time, air regulators will vote on the first of a suite of policies to dramatically accelerate the transition away from polluting gas appliances – setting the state on a path to cleaning up deadly ozone pollution.



State air regulators at the California Air Resources Board, and regional air regulators in the San Francisco Bay Area and L.A. Basin are all considering zero-emission appliance standards, which would require that specified appliances sold or installed beginning from a predetermined date be non-polluting alternatives to gas, like heat pumps. In the years before the standards take effect, air regulators would work with communities and stakeholders to ensure an equitable and affordable transition to clean appliances.

If California policymakers move forward with zero-emission standards and complementary equity policies, it would be a groundbreaking step in the transition off of fossil fuels in homes and businesses. Air regulators in the Bay Area project that implementation of their proposed zero-emissions standard – which would phase in beginning in 2027 – would cut 95% of NOx emissions from the baseline by 2046. <sup>5</sup> In the Bay Area, this reduction in NOx would be even more significant than the elimination of all of the region’s passenger cars. <sup>6</sup>

***Phasing out gas appliances in the Bay Area would deliver a more significant reduction in NOx pollution than eliminating all of the region’s gasoline passenger cars.***

### Topline findings from this literature review include:

1. Gas appliances in homes and buildings are a significant contributor to outdoor smog and particulate matter pollution and resulting health impacts in California communities.
2. The transition from gas appliances to electric alternatives could meaningfully improve air quality in California communities while delivering key climate, health, and resilience co-benefits.
3. State and local air quality agencies can dramatically accelerate the transition to electric appliances by moving forward with zero-emissions standards and a suite of complementary equity policies.

## Part 1: Gas Appliance Pollution and Health Impacts

Gas appliances like furnaces, water heaters, stoves, and clothes dryers generate NO<sub>x</sub> pollution from the combustion of fossil fuels. NO<sub>x</sub> reacts with volatile organic compounds (VOC) in the presence of heat and sunlight to create ozone – a major component of smog. Gas appliances also generate fine particulate matter (PM<sub>2.5</sub>), both directly as part of gas combustion, and indirectly when NO<sub>x</sub> reacts with ammonia in the atmosphere.

NO<sub>x</sub> pollution, ozone, and PM<sub>2.5</sub> pollution are all dangerous to human health. Nitrogen dioxide (NO<sub>2</sub>) pollution is associated with reduced lung function, increased asthma attacks, cardiovascular harm, lower birth weight in newborns, and greater likelihood of ER and hospital admissions.<sup>7</sup> Gas stoves are an especially significant source of indoor NO<sub>2</sub> pollution – 90% of homes will have unhealthy levels of NO<sub>2</sub> pollution after cooking with gas for just one hour.<sup>8</sup>

PM<sub>2.5</sub> is an array of very small particles that can lodge deep in the lungs and migrate to the bloodstream, affecting both respiratory and cardiovascular health. PM<sub>2.5</sub> was associated with 26,700 deaths in one year in California<sup>9</sup> and has been identified as the “air pollutant most harmful to the health of Bay Area residents.”<sup>10</sup>

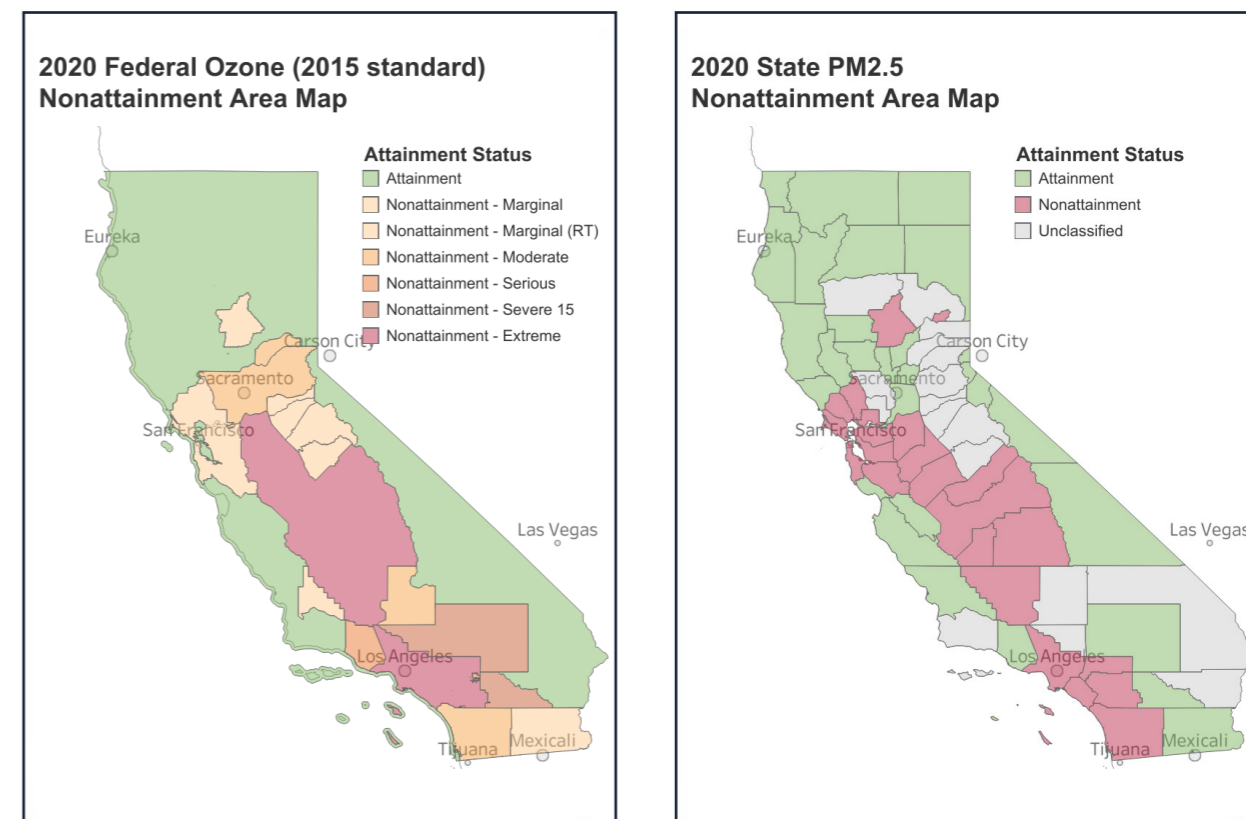
Ozone pollution harms human health by aggressively attacking lung tissue. Immediate impacts<sup>11</sup> from breathing ozone pollution can include shortness of breath, wheezing and coughing, asthma attacks, and increased risk of respiratory infections. Long-term exposure risks include premature death, respiratory harm, and cardiovascular harm.<sup>12</sup>

Californians are exposed to some of the highest levels of ozone pollution in the nation. According to the American Lung Association’s 2022 “State of the Air” report, six California cities are on the list of the nation’s top ten most ozone-polluted, and Los Angeles-Long Beach ranked as the most polluted city in the nation.<sup>13</sup> 19 areas in California have ozone levels that are so high that they are illegal under federal law. The nonattainment areas cover all the major population centers in California, and the L.A. Basin and the San Joaquin Valley are the nation’s only two “extreme” nonattainment areas.<sup>14</sup>

In the United States, California is one of only two states with areas out of attainment for PM 2.5, with Los Angeles, San Joaquin Valley, and parts of Imperial and Plumas counties exceeding federal standards.<sup>15</sup> When using the state’s stricter standards, the Bay Area is also out of attainment for PM<sub>2.5</sub>.

Communities of color and low-income Californians have suffered disproportionate health impacts from decades of exposure to poor air quality. NO<sub>x</sub>, PM<sub>2.5</sub>, and ozone concentrations vary block-by-block, with a recent study in the Bay Area finding that communities of color were exposed to 55% more NO<sub>2</sub> than mostly white neighborhoods.<sup>16</sup>

Figure 1. Most Californians live in areas that exceed federal standards for ozone pollution and state standards for PM 2.5.



Source: CARB Ambient Air Quality Standards Designation Tool.

<https://ww2.arb.ca.gov/aaqs-designation-tool>

**Neighborhoods with higher percentages of residents of color experience, on average, double the rate of pollution related childhood asthma compared to predominantly white neighborhoods.<sup>17</sup>**

### NEW INSIGHT INTO THE CHEMICAL COMPOSITION OF THE GAS THAT IS PIPED INTO HOMES:

A new study from Harvard T.H. Chan School of Public Health<sup>18</sup> has found the gas supplied to Massachusetts contains hundreds of chemicals and at least 21 different hazardous air pollutants that have been linked to cancer by the U.S. EPA,<sup>19</sup> including benzene, toluene, ethylbenzene, xylene, and hexane.

Researchers also found that small gas leaks – containing 20 parts per million methane – may not have enough odorant for people to detect them – suggesting that undetected gas leaks in homes and buildings may be far more prevalent than previously understood.

## ■ Part 2: Gas Appliance's Contribution to Pollution Can Be Addressed Through Electrification

To come into compliance with federal air quality standards for ozone, California state and regional air quality regulators must cut NOx pollution – of which gas appliances are a major contributor. Residential and commercial buildings in California are the source of about 66 tons per day of NOx statewide due to gas combustion — about four times the emissions from California's gas power plants and nearly two-thirds the emissions from California's roughly 16 million light-duty passenger cars. <sup>20</sup>

In the densely populated San Francisco Bay Area, residential gas appliances' contribution to ozone relative to other sources is even more significant – releasing more NOx <sup>21</sup> than all of the region's passenger cars and over seven times <sup>22</sup> as much NOx as the region's electric utilities. In the Los Angeles basin, residential and commercial gas combustion is responsible for 13% of total NOx emissions as of 2018. <sup>23</sup>

According to an analysis by RMI, many areas in California with the highest NOx pollution from buildings are also nonattainment or maintenance areas for ozone standards, suggesting that cutting pollution from appliances is a key strategy for improving local air quality and protecting health. <sup>24</sup> As a result of this appliance pollution, fossil fuel use in homes and buildings in California is responsible for 470 deaths and over \$5 billion in health impact costs, according to analysis from RMI. <sup>25</sup>

Transitioning homes from gas appliances to clean electric alternatives like heat pumps can dramatically reduce dangerous air pollution from homes and buildings, delivering meaningful air quality benefits in communities across California — especially in the low-income communities and communities of color that breathe higher levels of appliance pollution.

In fact, South Coast Air Quality Management District (SCAQMD) regulators tasked with developing policies to meet federal air quality standards have acknowledged that extensive use of zero-emission technologies will be required across stationary and mobile sectors, including homes and buildings. <sup>26</sup>

**Homes and buildings in California generate four times more NOx pollution than California's gas power plants and nearly two-thirds as much NOx as California's 16 million passenger cars.**

According to research from UCLA, replacing all residential gas appliances in California with clean electric alternatives would prevent 354 premature deaths, 596 acute cases of bronchitis, and 304 cases of chronic bronchitis annually through outdoor air quality improvements in PM<sub>2.5</sub> pollution. <sup>27</sup> These health benefits, while considerable, only account for improvements to outdoor air – improvements in indoor air quality would likely generate considerable additional health benefits.

Detailed analysis from the Bay Area Air Quality Management District (BAAQMD) showed that using zero-emission appliances for space and water heating would substantially reduce PM<sub>2.5</sub> pollution in the region. Eliminating PM<sub>2.5</sub> from water heaters, furnaces and boilers would eliminate approximately 65 premature deaths, 7,000 lost work days, 15,000 incidents of asthma symptoms, and 120 new asthma cases a year. <sup>28</sup> They valued the health benefits at approximately 700 million a year. These staggering health benefits only reflect the PM<sub>2.5</sub> reductions – there are additional health benefits that haven't been modeled for the NOx and ozone reductions.

### Eliminating PM<sub>2.5</sub> from Bay Area water heaters, furnaces and boilers would eliminate approximately:



**65**

**PREMATURE  
DEATHS**



**7,000**

**LOST WORK  
DAYS**



**15,000**

**ASTHMA  
SYMPTOM  
INCIDENTS**

### CLIMATE CO-BENEFITS FROM A TRANSITION TO ELECTRIC APPLIANCES

In addition to significant air quality benefits, the climate co-benefits from a transition off of gas in homes and buildings would be significant. Homes and buildings are responsible for roughly 25% of California's total greenhouse gas emissions – and the burning of fossil fuels in homes and buildings alone is responsible for roughly 10% of state-wide emissions.

BAAQMD projects implementation of its zero-emissions standard would cut greenhouse gas emissions from residential and commercial space and water heating roughly 82% by 2045 compared to a 2019 baseline in the Bay Area. <sup>29</sup>

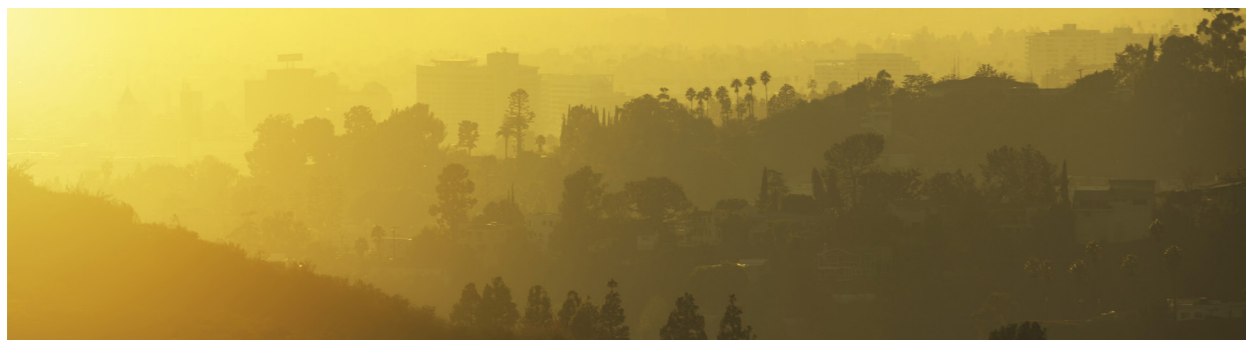
## Part 3: Policy Solution: Zero-Emission Appliance Standards and Equity-Centered Policies

California air agencies are preparing for a transition away from polluting appliances by developing zero-emission appliance standards – a regulation that would require certain appliances sold after a predetermined date to be pollution-free. These standards will need to be accompanied by a suite of equity-centered policies that get enacted before the standards take effect.

Zero-emission appliance standards will improve air quality and public health by removing major sources of pollution from our homes and businesses. These regulations would apply to manufacturers, distributors, sellers, and installers at point of sale, meaning only non-polluting appliances will be available for purchase. Replacing gas appliances at their end of life is the most cost-effective time for consumers to make the switch to zero-emission appliances. At present, the primary feasible technology to meet a zero-NOx standard are electric-powered appliances, which produce no onsite pollution.

In the years prior to the zero-emission appliance standards taking effect, policymakers and market actors need to focus on creating the conditions for equitable and affordable implementation of those standards. The transition off of fossil fuels in homes and buildings can serve as an important opportunity to advance housing and environmental justice by improving air quality in communities, reducing public health risks, and boosting access to cooling in the face of climate-fueled heat waves. To ensure that the communities of color and low-income communities most burdened by air pollution, the climate crisis, and high energy bills benefit from electrification, and are not burdened by the cost of the transition, these communities should be deeply involved in designing both the standards and the complementary equity-focused policies that are enacted before the standards go into effect.<sup>30</sup>

Zero-emission appliance standards are under consideration from state air regulators at the California Air Resources Board (CARB), as well as regional air regulators at BAAQMD and SCAQMD.<sup>31</sup>



## POLICY LANDSCAPE

- **STATEWIDE:** The California Air Resources Board is considering<sup>32</sup> zero-greenhouse-gas-emission standards by 2030 as a part of California's State Implementation Plan for achieving federal air quality standards<sup>33</sup> for ozone pollution. The proposal commits to standards for residential and commercial furnaces and water heaters, but may be expanded to include other end-uses. The Board will consider the State Implementation Plan on September 22-23. If approved, CARB will begin a stakeholder engagement process and a rulemaking for the zero-emission appliance standards, which would be brought to the Board for adoption by 2025.
- **BAY AREA:** Air regulators at the Bay Area Air Quality Management District (BAAQMD) have proposed zero-NOx emission standards starting in 2027 for small water heaters, 2029 for furnaces, and 2031 for large water heaters and boilers. The District Board plans to vote on the rules in Q4 2022.<sup>34</sup>
- **LOS ANGELES BASIN:** As part of the district's draft Air Quality Management Plan for meeting the 2015 federal ozone standard, air regulators at the South Coast Air Quality Management District have proposed zero or near-zero NOx measures for gas furnaces, water heaters, stoves, and other appliances starting in 2029 for residential buildings and 2031 for commercial buildings.<sup>35</sup> The final Plan should be released in fall 2022, followed by a Board vote. If approved, a rulemaking for the zero emission appliance standards should begin soon after to prepare for rule adoption in 2024-2025.

If state and local air regulators move forward with zero-emissions standards, the air quality benefits would be substantial. CARB's proposed standards could cut statewide NOx pollution roughly 20% from today's levels, a reduction of 13.55 tons per day in 2037.<sup>36</sup> If CARB expands its standards to include other appliances beyond space and water heaters, it could reduce NOx by 19.96 tons per day in 2037.<sup>37</sup> In the Los Angeles Basin where ozone pollution is the worst in the nation, SCAQMD – which has proposed measures for many appliance categories – expects to reduce NOx 14.79 tons per day by 2037.<sup>38</sup> In the Bay Area, BAAQMD – which has proposed the earliest implementation date – expects its standards will cut 95% of NOx emissions from 2015 levels by 2046, the projected date of complete appliance changeout.<sup>39</sup>

These pollution reductions will deliver much needed health and air quality benefits to Californians, and if done right, policymakers can help ensure that communities of color and low-income communities are realizing these benefits as soon as possible without adverse cost impacts. BAAQMD is the farthest along in its policy proposal, and it has incorporated two key protections to ensure equitable implementation of its rules. First, it will initiate a stakeholder working group as soon as the rules pass that will help ensure market actors are creating the conditions necessary for equitable and affordable implementation by the planned dates.

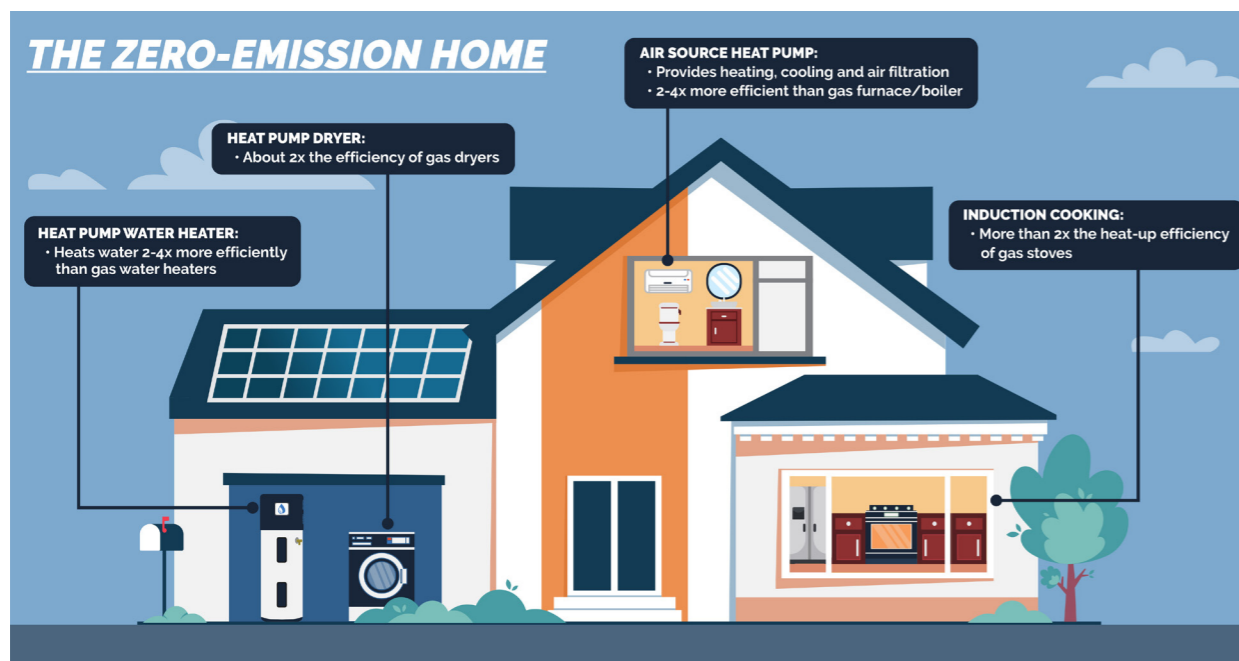
**A proposed zero-emission standard in the Bay Area would cut 95% of NOx pollution from homes and buildings by 2046.**

Second, BAAQMD will evaluate whether equitable and affordable implementation is feasible by the planned date two years before the rules take effect. These commitments promise to deliver the benefits of clean-fueled appliances to Bay Area residents with equity and financial safeguards.

Though at an earlier stage than BAAQMD, CARB's State Implementation Plan recognizes zero-emission appliance standards as "part of a suite of equity-promoting and complementary building decarbonization policies deeply informed by public process." CARB lists increasing affordability through incentive programs and improved utility rates, developing the workforce, reducing gas infrastructure, increasing construction of zero-emission buildings, and increasing consumer education as some of the complementary policies that the state must enact to support equitable zero-emission standards. CARB will collaborate with community members, other agencies, industry representatives, and environmental stakeholders to help design the standards and ensure equitable implementation.

SCAQMD is at the earliest stage of policy development, revealing only the desired appliance categories it will regulate in the coming years, but it can and should pursue similar protections and processes as the State and Bay Area regulators as its policies progress.

California's air agencies have taken a significant first step to reduce building pollution by proposing zero-emission appliance standards. Once the Air Boards pass these landmark clean air policies, air regulators will have five to ten years to ensure equitable and affordable rule implementation by collaborating closely with community representatives and mobilizing decisionmakers to enact complementary equity policies.



Sources for efficiency comparisons: RMI [Fact Sheet on Stoves](#), RMI [Clean Energy 101: Heat Pumps](#), RMI [Heat Pumps for Hot Water](#), and SPUR analysis of [Energy Star-Rated Clothes Dryers](#)

## Resiliency, health and economic benefits from an equitable transition to electric heat pumps in homes include:

**Increased access to cooling in the face of climate fueled heat waves.** A recent report to the California Legislature on climate impacts across California finds that low-income households in California, which are disproportionately communities of color, are less likely <sup>40</sup> to live in homes with central air conditioning than high-income households. Research <sup>41</sup> from USC on access to cooling in the L.A. area finds that poverty is a better predictor for lack of cooling than climate zone.

Transitioning homes to highly-efficient electric heat pumps could provide affordable cooling to the roughly 24% – or 3.4 million – California homes that lack central air conditioning – helping to meet a critical gap in climate resiliency that is especially pressing in low-income communities and communities of color. <sup>42</sup> Heat pumps provide households with cooling that is 50% more efficient than window A.C. units – lowering cooling bills.

**Improved indoor air quality.** The transition off of gas appliances in favor of highly-efficient electric alternatives will improve air quality indoors and out. In addition to cutting lung-damaging outdoor NOx and ozone pollution, heat pumps also provide air filtration benefits – which are especially important during California's increasingly long wildfire season. Modern heat pumps can be outfitted with plasma filters, ionic filters, and high-efficiency particulate air (HEPA) filters, which can significantly improve air quality inside homes. <sup>43</sup>



## LEGAL MECHANISMS FOR CLEAN AIR:

Air agencies - both state and regional - have ample legal authority to adopt standards requiring zero-emission appliances. <sup>44</sup> The federal Clean Air Act requires states to adopt and enforce State Implementation Plans (SIPs) to show how they will reduce pollution and attain National Ambient Air Quality Standards (NAAQS). In their SIPs, states must demonstrate that they are implementing all "reasonably available control technology" (RACT) that are economically and technologically feasible, which can include zero-emission appliances.

Under California law, regional air districts have authority to regulate pollution from stationary sources of emissions, including appliances, and these regulations may be more stringent than state standards from the California Air Resources Board. Thus, both state and regional air regulators can enact zero-emission appliance standards.

In fact, because NOx pollution is a precursor to ozone, and because the many California air districts that are not in attainment with federal standards for ozone have a legal obligation under the federal Clean Air Act to come into attainment "as expeditiously as practicable," there is a strong argument that air districts are actually legally obligated to pursue stronger standards for home appliances.

## Conclusion

California cannot deliver the clean air communities across the state urgently need without cleaning up pollution from gas appliances in homes. The technology needed to eliminate this pollution – the electric heat pump – is readily available, and provides key climate, health, and resiliency co-benefits. By moving forward with zero-emission standards – and pairing these policies with a suite of tenant protection and equity measures – state and regional air agencies can kickstart a transition to electric heat pumps in homes that will be transformative for Californians, providing cleaner air indoors and out, accelerating our state's progress towards meeting our climate targets, and expanding access to clean air and cooling in homes.



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<sup>22</sup> California Air Resource Board. n.d. "CEPAM2019v1.03 - Standard Emission Tool | California Air Resources Board." Ww2.Arb.ca.gov. California Air Resource Board. <https://ww2.arb.ca.gov/applications/cepam2019v103-standard-emission-tool>.

<sup>23</sup> South Coast AQMD, "Policy Brief: Residential and Commercial Building Appliances," 2022, <http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/combined-residential-and-commercial-buildings-appliance.pdf?sfvrsn=8>.

<sup>24</sup> Dennison, Jim, Leah Louis-Prescott, and Talor Gruenwald. 2021. "How Air Agencies Can Help End Fossil Fuel Pollution from Buildings." RMI. <https://rmi.org/insight/outdoor-air-quality-brief>.

<sup>25</sup> These values are based on additional analysis from Jonathan Buonocore, Sc.D, the study's lead author, RMI used median estimates from the results of 3 reduced complexity models used in: Jonathan J Buonocore (Harvard T.H. Chan School of Public Health) et al, "A decade of the U.S. energy mix transitioning away from coal: historical reconstruction of the reductions in the public health burden of energy", 2021 *Environ. Res. Lett.* 16 054030, <https://doi.org/10.1088/1748-9326/abe74c>. These values estimate the impacts of fossil fuel use in residential and commercial buildings in California.

<sup>26</sup> South Coast Air Quality Management District Governing Board. 2022. "Revised Draft 2022 Draft Air Quality Management Plan." South Coast Air Quality Management District. SCAQMD. <http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/revised-draft-2022-aqmp/revised-draft-2022-aqmp.pdf?sfvrsn=4>

<sup>27</sup> Zhu, Y., R. Connolly, Y. Lin, T. Mathews, and Z. Wang. "[Effects of Residential Gas Appliances on Indoor and Outdoor Air Quality and Public Health in California \(No. 20184996\).](#)" (2020).

<sup>28</sup> Martien, Phil. Building Appliance Rules: Benefits to Outdoor Air Quality and Health. BAAQMD, 2022. [https://www.baaqmd.gov/~media/files/board-of-directors/advisory-council/2022/acr-presentations\\_021422\\_op-pdf.pdf?la=en&rev=bccd129700854809a8b4047f69c04fb0](https://www.baaqmd.gov/~media/files/board-of-directors/advisory-council/2022/acr-presentations_021422_op-pdf.pdf?la=en&rev=bccd129700854809a8b4047f69c04fb0).

<sup>29</sup> Bay Area Air Quality Management District. 2021. "Workshop Report Draft Amendments to Building Appliance Rules – Regulation 9, Rule 4: Nitrogen Oxides from Fan Type Residential Central Furnaces and Rule 6: Nitrogen Oxide Emissions from Natural Gas-Fired Boilers and Water Heaters." San Francisco Bay Area: Bay Area Air Quality Management District. [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?la=en](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?la=en).

<sup>30</sup> Equity-focused groups have shared recommendations on processes and policies that are necessary to ensure an equitable transition, such as Greenlining Institute's [Equitable Building Electrification report](#), SAJE's [Los Angeles Building Decarbonization: Tenant Impact and Recommendations report](#), CEJA's [Environmental & Housing Justice Policy Platform](#), and the Building Energy, Equity, and Power (BEEP) Coalition's [comment letter to CARB and Equitable Building Decarbonization report](#).

<sup>31</sup> CARB is proposing zero-greenhouse gas standards, using its authority to regulate greenhouse gases statewide and also consider related criteria pollutant reduction benefits, while regional air districts are proposing zero-NOx standards, using their authority to regulate stationary source criteria pollutants.

<sup>32</sup> California Air Resources Board, "Proposed 2022 State Strategy for the State Implementation Plan," August 12, 2022, [https://ww2.arb.ca.gov/sites/default/files/2022-08/2022\\_State\\_SIP\\_Strategy.pdf](https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf)

<sup>33</sup> US EPA,OAR. 2018. "NAAQS Table | US EPA." US EPA. US EPA. December 11, 2018. <https://www.epa.gov/criteria-air-pollutants/naaqs-table>.

<sup>34</sup> Bay Area Air Quality Management District. 2021. "Workshop Report Draft Amendments to Building Appliance Rules – Regulation 9, Rule 4: Nitrogen Oxides from Fan Type Residential Central Furnaces and Rule 6: Nitrogen Oxide Emissions from Natural Gas-Fired Boilers and Water Heaters." San Francisco Bay Area: Bay Area Air Quality Management District. [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?la=en](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?la=en).

<sup>35</sup> South Coast Air Quality Management District Governing Board. 2022. "Revised Draft 2022 Draft Air Quality Management Plan." South Coast Air Quality Management District. SCAQMD. <http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/revised-draft-2022-aqmp/revised-draft-2022-aqmp.pdf?sfvrsn=4>

<sup>36</sup> California Air Resources Board, "Proposed 2022 State Strategy for the State Implementation Plan," August 12, 2022, [https://ww2.arb.ca.gov/sites/default/files/2022-08/2022\\_State\\_SIP\\_Strategy.pdf](https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf)

<sup>37</sup> California Air Resources Board, "Proposed 2022 State Strategy for the State Implementation Plan," August 12, 2022, [https://ww2.arb.ca.gov/sites/default/files/2022-08/2022\\_State\\_SIP\\_Strategy.pdf](https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf)

<sup>38</sup> American Lung Association. 2022. "Most Polluted Cities | State of the Air." Wwv.lung.org. American Lung Association. 2022. <https://www.lung.org/research/sota/city-rankings/most-polluted-cities>.

<sup>39</sup> Jennifer Elwell. "Workshop Report: Draft Amendments to Building Appliance Rules" pp 10. Bay Area Air Quality Management District, September 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?la=en](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?la=en)

<sup>40</sup> California, Legislative Analyst's Office. 2022. "Climate Change Impacts across California - Housing." Lao.ca.gov. April 5, 2022. <https://lao.ca.gov/Publications/Report/4584>.

<sup>41</sup> News, University of Southern California. 2020. "Urban Heat Waves Imperil L.A.'S Most Vulnerable Communities." USC News. University of Southern California. May 19, 2020. <https://news.usc.edu/166707/urban-heat-waves-los-angeles-vulnerable-communities-usc-research/>.

<sup>42</sup> 2019 American Housing Survey.

<sup>43</sup> BlocPower. 2021. "Do Heat Pumps Purify Air? Yes! Learn How Heat Pumps Improve Air Quality." Wwv.blocpower.io. October 28, 2021. <https://www.blocpower.io/posts/do-heat-pumps-purify-air>.

<sup>44</sup> Dadashi, Heather, Cara Horowitz, and Julia Stein. "[How Air Districts Can End NOx Pollution from Household Appliances.](#)" (2022).

