EXTREME HEAT IN OREGON: HOW TO ALLEVIATE THE BURDEN OF POOR INDOOR AIR QUALITY ON VULNERABLE RESIDENTS THROUGH PROTECTIVE STANDARD SETTING SCHEMES

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EXECUTIVE SUMMARY

"It's getting hot in here!"[1] Extreme heat events—wildfires and heatwaves—in the Pacific Northwest increase harmful particulate matter (PM) in residential buildings, leading to life-threatening respiratory and circulatory complications. PM-health effects disproportionately harm those living in older buildings and landlord-tenant residences, those with pre-existing health issues, and those in minority groups. At current, Oregon does not have any enforceable residential indoor air quality standards and uses voluntary mitigation funding to address poor indoor air quality related to climate change, yet extreme heat events will continue to harmfully impact Oregon communities absent explicit indoor air quality standards. Given the impending threats underlying extreme heat events, activists and policymakers should push for Oregon Health Authority (OHA) to adopt indoor air quality PM standards during extreme heat events, Oregon Department of Environmental Quality (ODEQ) Environmental Quality Committee (EQC) to create an indoor air quality testing accreditation program under ORS 468A.775, and Oregon Housing and Community Services (OHCS) to oversee enforcement of future indoor air quality standards for ORS Chapter 90 Landlord-Tenant Residences.

I. INTRODUCTION AND SCOPE

Picture this: it's the year 2050. Oregon's long summer days are no longer suitable for evening boating on the Willamette, an afternoon hike in the Cascades, or an iced latte at your favorite coffee shop's outdoor patio in the morning. Instead, Oregon State's Heat Advisories blare throughout the summer months, urging Oregonians to stay

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[1] Nelly, *Hot in Herre,* (Universal Records 2002).

indoors, stay hydrated, and protect themselves against harmful ambient air quality. While we can all hope that this melting futurity is mitigated before our climate is irreversibly changed, isolated extreme heat events like wildfires and heatwaves continue to increase in severity and affect the Pacific Northwest. To prepare for these climatological events, regulating and monitoring indoor air quality (IAQ) is a pragmatic approach to protect human health and improve habitability of the built environment. In effort to aid Oregon non-profits, community groups, government planners, and grassroots policymakers, this paper explores the many ways indoor air quality can be protected and enhanced by mitigating technology, public grant programs, informed policy decisions, and standard-setting regulatory schemes.

First, this paper will frame the issue of extreme heat events in the Pacific Northwest (PNW). Second, this paper will explain particular harms PM causes the human body and identify the most vulnerable populations affected by such harms. Third, this paper will explore the technological mitigations that protect IAQ. Fourth, this paper will outline the "Wild-West" that is indoor air quality monitoring, emphasizing that individual states play a pivotal role in policy making. Finally, this paper will propose IAQ policy recommendations for Oregon's Landlord-Tenant residences in the face of increasing extreme heat events.

While indoor cooling is an equally important issue related to extreme heat events, only indoor air pollution issues will be discussed in this paper. Due to the pervasive and harmful nature of airborne particulate matter (PM), this paper focuses on recommendations for indoor PM standards and monitoring, although other airborne pollutants, like volatile organic compounds (VOCs), pose a heightened threat to human health during extreme heat events.[2] This paper specifically addresses residential buildings' IAQ standards and monitoring because residents will likely "shelter-in place" at home, to avoid poor ambient air quality resulting from extreme heat events.[3]

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[2] PAULA SCHENCK ET. AL., CLIMATE CHANGE, INDOOR AIR QUALITY AND HEALTH, 9 (Univ. Conn. Health Ctr. ed., 2010).

[3] There are multiple regulatory schemes for other use classifications of the built environment. For example, Oregon's Occupational Health and Safety Administration (OR-OSHA) sets state building safety standards for all places of employment. *See*, OR. REV. STAT. § Ch. 654 (2021).

II. BACKGROUND

A. Extreme Heat Events Worsen Indoor Air Quality.

From late July to September, the typical PNW wildfire season, Oregon's wildfire advisories recommend that residents stay inside during wildfire events to avoid the poor ambient air quality.[4] Unfortunately, poor ambient air quality can also cause airborne pollutants to concentrate inside residences and affect indoor air quality.[5] Wildfire-induced pollutants enter homes through open windows, cracks, and small gaps in building seals and accumulate in homes with improper ventilation systems.[6] For some, the best way to improve indoor filtration during wildfires was to "duct tape square air filters, bought at Home Depot, to a stack of box fans."[7] Although innovative, jerry-rigged ventilation hacks are not effective, long term strategies to combat poor IAQ.

In 2021, Oregon's June heatwave tied the hottest temperature ever recorded in the state, at 119° Fahrenheit.[8] Heatwaves, like those experienced in the Pacific Northwest, are problematic to air quality because they stagnate air and trap other airborne particulate matter until rain or windfall occurs.[9] Because heatwaves cause intense evaporation and stagnate ambient air flow, they create the potential for dust, pollen, and other allergens to accumulate geographically and inevitably enter into buildings and homes.[10] Climate scientists predict that as the ambient temperature of the earth continues to rise, wildfires and heatwaves in the Pacific Northwest will increase in severity and

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[4] *See e.g.,* OR DEQ, *Oregon Smoke Information*, https://www.oregonsmoke.org (last visited Sept. 20, 2022).
[5] Institute of Medicine, *Climate Change, the Indoor Environment, and Health,* The National Academies Press, at 98, 105-106 (https://doi.org/10.17226/13115) (2011) [Hereinafter, *Climate Change, the Indoor Environment, and Health*].
[6] *Id. at 98-99, 101, 104.*
[7] Nathan Rott, *Sheltering Inside May Not Protect You From The Dangers Of Wildfire Smoke*, NPR (Sep. 7, 2021, 4:50 PM) https://www.npr.org/2021/09/07/1034895514/sheltering-inside-may-not-protect-you-from-the-dangers-of-wildfire-smoke.top
[8] Alex Hasenstab, *Oregon's 2021 heat dome notches another record,* OPB (Feb. 10, 2022 4:01 PM) https://www.opb.org/article/2022/02/10/oregons-2021-heat-dome-notches-another-record/.
[9] *See e.g.,* Center for Climate and Energy Solutions (C2ES), *Heat Waves and Climate Change, https://www.c2es.org/content/heat-waves-and-climate-change/* (last visited Sept. 20, 2022).
[10] *See e.g.,* Climate Change, the Indoor Environment, and Health *supra* note 4, at 108.

intensity.[11] Thus, the term "extreme heat events" is used in this paper to mean meteorological or natural events—like wildfires and heatwaves—that are predicted to increasingly worsen as a consequence of climate change.

Extreme heat events are a malevolent force of nature that affect the outside—or ambient— air and the inside air we breathe. The Environmental Protection Agency Office of Research and Development (EPA ORD) has administered multiple studies to research climate change's relationship to IAQ, specifically exploring the relationship between poor ambient air quality and its effect on IAQ.[12] EPA ORD found that "indoor levels of pollutants may be 2 to 5 times, and occasionally 100 times higher than outdoors," suggesting that external air pollutants not only enter into residences, but accumulate and remain in buildings when adequate ventilation or remedial measures are not utilized.[13] Additionally, specific categories of air contaminants may be further exacerbated by climate change events, including biological contaminants (e.g., mold, dust, pollen), particulate matter, smoke, volatile organic compounds (VOCs), and ozone (created from electronic machines, e.g., filtration devices).[14] In the presence of increasingly higher summer temperatures, Oregonians need to be prepared to experience poor IAQ to guard against the harmful health consequences caused by airborne pollution.

B. The Harmful Health Effects of Particulate Matter Targets Vulnerable Communities

Airborne particulate matter is categorized by the size of the particulate suspended in the air. For example, $PM_{2.5}$ is particulate matter with a diameter of 2.5 micrometers (μm) or smaller, while PM_{10}

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[11] Elena Grigorieva & Artem Lukyanets, *Combined Effect of Hot Weather and Outdoor Air Pollution on Respiratory Health: Literature Review*, 12 ATMOSPHERE 790,7-15, 2021, https://doi.org/10.3390/atmos12060790.

[12] DAVID H. MUDARRI, BUILDING CODES AND INDOOR AIR QUALITY (The Cadmus Grp. ed., 2010);
TERRY BRENNAN, INDOOR ENVIRONMENTAL QUALITY AND CLIMATE CHANGE (Camroden Assoc. ed., 2010);
PAULA SCHENCK ET. AL., CLIMATE CHANGE, INDOOR AIR QUALITY AND HEALTH (Univ. Conn. Health Ctr. ed., (2010).

[13] PAULA SCHENCK ET. AL., CLIMATE CHANGE, INDOOR AIR QUALITY AND HEALTH, 4 (Univ. Conn. Health Ctr. ed., (2010).

[14] *Id.* at 4-9.

has a diameter of 10 µm.[15] For comparison, both $PM_{2.5}$ and PM_{10} air particles are smaller than the diameter of the average human hair![16] Wildfires produce combustion particles that can be smaller than $PM_{2.5}$, while dust and allergens are usually smaller than PM_{10}.[17] Because extreme heat related PM is so fine, particles easily pass through the human body and into the lungs and—if small enough—bloodstream.[18] Along with general respiratory irritation, studies show that PM exposure can increase the likelihood of premature death in people with heart or lung disease, nonfatal heart attacks, irregular heartbeat, aggravated asthma, and decreased lung function.[19]

Research into climate change and social vulnerability paints a far from pretty picture for those with underlying social inequities. Ambient air quality and PM exposure pose a harm to many vulnerable groups, including minorities, the young and the old, and people with pre-existing health conditions.[20] EPA's air quality research found that PM health problems are more prevalent in minority groups, "about 75% of $PM_{2.5}$ exposure . . . disproportionately affects racial-ethnic minorities."[21] Specifically, climate-driven $PM_{2.5}$ is nationally projected to increase premature mortality in individuals 65 and older.[22] Black or African American individuals have the highest comparative risk of premature death compared to any other vulnerable group, because they often live in areas with the highest projected increases in premature death.[23] Children are also more likely to be diagnosed with asthma as $PM_{2.5}$ exposure increases with climate-driven events.[24] At the national level, Black or African American children at a higher risk

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[15] Climate Change, the Indoor Environment, and Health *supra* note 4, at 99.
[16] EPA, *Why Wildfire Smoke is a Health Concern,* https://www.epa.gov/wildfire-smoke-course/why-wildfire-smoke-health-concern (last visited May 2, 2022).
[17] *Id.*
[18] EPA, *Health and Environmental Impacts of Particulate Matter (PM),* https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm (last visited May 2, 2022).
[19] *Id.*
[20] *Id.*
[21] Christopher W. Tessum et. al., *$PM_{2.5}$ Polluters Disproportionately and Systemically Affect People of Color in the United States,* 7 Science Advances, no. 18, (2021), https://www.science.org/doi/10.1126/sciadv.abf4491.
[22] EPA, *Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts*, Sept. 2021, 22-25, EPA 430-R-21-003, www.epa.gov/cira/social-vulnerability-report (hereinafter "National Study"). At 2°C global warming increase, there is a projected annual increase of 2,100 deaths, and at 4°C global warming increase, there is a projected annual increase of 5,800 deaths. *Id.*
[23] *Id.* at 25. Black or African American individuals have a 41-60% higher risk of premature death than other minority groups. *Id.*
[24] *Id.* at 27.

of asthma diagnosis than other minority groups, because they currently live in areas with the highest projected increases of diagnoses.[25]

The harms of PM exposure also disproportionately impact geographically specific areas and low socioeconomic groups. High-poverty neighborhoods have greater exposure to $PM_{2.5}$ and ozone and have overall higher ambient air pollution.[26] Extreme heat events will continue to contribute to this disparity in densely populated urban environments, where the built environment locks in heat, creating the phenomenon known as "urban heat islands" (UHIs).[27]

Another vulnerability consideration—directly tied to many of the groups examined above—is the type of residence one lives in. Older homes and apartments are the most vulnerable because they are poorly weatherized and often lack central air filtration and ventilation systems. Residences built in the historically rich but building code lax times are still standing throughout Oregon, in both rural and urban areas. In the case of wildfire smoke, which in the 2020 wildfire season spread across much of the state and impacted ambient air quality to unhealthy and hazardous levels at a regional scale, it is not an overreach to suggest that indoor air quality will be an issue felt by many Oregonians in older residences in the very near future.[28]

The final consideration regarding those with increased vulnerabilities to poor IAQ is the matter of autonomy over one's

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[25] *Id.* Black or African American children have a 34-41% higher risk of asthma diagnosis than other minority groups. *Id.*

[26] *Id.* at 21. Note, in the National Study, the greater felt impact of IAQ on racial minorities is projected to occur in states that have higher populations of racial minorities than Oregon. However, at an intrastate level, the trends of the National Study still ring true to Oregon's own population. *See e.g.,* Cassandra Profita, *Study: More People Of Color Live Near Portland's Biggest Air Polluters*, OPB, (April 29, 2020, 6:45 a.m.), https://www.opb.org/news/article/oregon-portland-study-people-of-color-polluted-neighborhoods-redlining-covid-19/.

[27] P. RAMAMURTHY & E. BOU-ZEID, *Heatwaves and urban heat islands: A comparative analysis of multiple cities,* 122 J. Geophysical Research, 168-178 (2016), doi:10.1002/2016JD025357. Urban heat islands are areas of dense human population that amplify temperature that have been increased due to a variety of factors: the thermal storage of a city's built materials (e.g., concrete, asphalt and steel), the lack of surface materials' ability to store moisture, the use of equipment that produces heat (e.g., heat rejected by air conditioners and combustion from gas-powered cars), and the lack of geophysical features like waterbodies or rural areas near the UHI. *Id.* at 168.

[28] OR DEQ, *Wildfire smoke brings record poor air quality to Oregon, new data shows,* (Sept. 16, 2020), https://deqblog.com/2020/09/16/wildfire-smoke-brings-record-poor-air-quality-to-oregon-new-data-shows/ (The air quality index (AQI) for all five major Oregon cities (Portland, Eugene, Bend, Medford, and Klamath Falls) ranged from 477-500+ AQI. All levels recorded were new daily records for each city and were deemed hazardous or beyond the upper limit of the AQI).

domain. Residential lessees with limited control over their dwellings are less able to make executive decisions about how their living spaces are managed to prevent poor indoor air quality; this is a vulnerability not quantitatively measured but anecdotally clear. Residents leasing dwellings do not carry the entire "bundle of sticks" of rights that, in contrast, a legal title owner would have over their property. Thus, the hypothetical solution to "build over" a residence's imperfections to prevent poor IAQ—like performing improvements to add central heating, ventilation, and air conditioning (HVAC) units or to improve a dwelling's "weatherization"—are expensive and illusory solutions that would yield only temporary protections for leaseholders holding contractually limited rights to property. As it stands, there is no valuable incentive for a tenant to dramatically improve their residence to protect themselves from poor indoor air quality.

As suggested in this paper, by regulating PM exposure in the built environment, Oregon's state government can take an active step in protective policymaking to address the health-based inequities in our community that are exacerbated by exposure to extreme heat events. Examined in detail later, a regulatory approach to monitor IAQ PM would require landlords to prepare or remediate their tenants' residences when sheltering in place from wildfires and heatwaves.

C. Technological and Physical Mitigations that Protect Indoor Air Quality

The story of indoor air quality cannot be told without understanding the roles of certain technological and physical features that mitigate the flow of poor-quality ambient air into residences. This section provides a brief overview of physical preventative measures that can be employed in residences during extreme heat events.

1. HVAC Systems and Filtration Devices can decrease Indoor PM.

The adoption of central HVAC units has vastly improved residential indoor air quality and offers air quality protection via filtration during extreme heat events. HVAC specialists, as well as the EPA, recommend that central air conditioning units should contain MERV-

rated[29] 13-16 filters when ambient air quality is poor.[30] It is recommended that filters are replaced every six months to a year, dependent on the ambient air quality.[31] Other filtration options for HVAC systems include carbon catches or UV light filters.[32]

While central HVAC units are very beneficial, they are a commodity unavailable to many Oregonians. In the Portland Metro Area, only 49% out of 955,100 housing units contain central air conditioning units.[33] Out of the remaining housing units, 29% have room conditioning units while 21% of housing units do not have air conditioning at all.[34] EPA suggests for residences without central HVAC systems, the best option is to obtain a portable filtration device with a high-efficiency HEPA filter when ambient PM increases from extreme heat events.[35]

2. Energy Efficiency through Weatherization Improves IAQ.

Improving the energy efficiency of residences has a dual-purpose climate rationale: (1) it is a direct way to reduce greenhouse gas emissions; and (2) it can improve IAQ during extreme heat events by decreasing unintentional air flow between indoor and external environments.[36] "Weatherization" is the term used to define

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[29] MERV ratings calculate a filter's efficiency at removing different sizes of particulate. For example, a MERV-10 filter can remove 1.0 - 3.0 µm particles with less than or equal to 50% efficiency and 3.0 - 10.0 µm particles at less than 80% efficiency. EPA, *What is a MERV rating?,* https://www.epa.gov/indoor-air-quality-iaq/what-merv-rating (Last visited Sept. 20, 2022).

[30] Interview, Bryan Delfino, HVAC Specialist, in Salem, Or. (Feb. 20, 2022); EPA, *Preparing for Fire Season,* https://www.epa.gov/wildfire-smoke-course/preparing-fire-season (last visited Sept. 21, 2022) ("Upgrading to a filter rated MERV 13 or higher can be especially important during smoky periods to effectively remove fine particle pollution from smoke in the indoor air").

[31] *Id.*

[32] *Id.*

[33] U.S. CENSUS BUREAU, *American Housing Survey 2019,* https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html?s_areas=38900&s_year=2019&s_tablename=TABLE3&s_bygroup1=1&s_bygroup2=1&s_filtergroup1=1&s_filtergroup2=1 (Select area "Portland, OR;" select year "2019;" select table "Heating, Air Conditioning, and Appliances") (470,900 households have central air conditioning, 279,400 have room air conditioning, and 204,800 have no air conditioning) (last visited Sept. 21, 2022).

[34] *Id.*

[35] EPA, *Preparing for Fire Season,* https://www.epa.gov/wildfire-smoke-course/preparing-fire-season (last visited Sept. 21, 2022).

[36] However, improving a building's sealing can also lower the total ventilation rate of a building. When building ventilation is lowered, a potential negative effect is that indoor contaminants can accumulate. *See* TERRY BRENNAN, INDOOR ENVIRONMENTAL QUALITY AND CLIMATE CHANGE (Camroden Assoc. ed., 2010), at 12 (sealing buildings lowers

improvements meant to better protect buildings from environmental conditions and control internal conditions. Weatherization techniques include retrofitting homes with mechanical improvements like central ventilation and filtration, constructing shell improvements (e.g. sealing), installing efficient electric and water sources, and adding health and safety measures like smoke and carbon monoxide alarms.[37]

The U.S. Department of Energy (DOE) spearheads federal projects to improve the energy efficiency of buildings. In 1976, DOE implemented the Weatherization Assistance Program (WAP)—at the time to respond to escalating fuel prices from the fuel embargoes of the 1970s.[38] Now, the program continues to help weatherize existing homes.[39] EPA ORD studies show that weatherization techniques like sealing older buildings, centralizing ventilation and filtration, and sealing off unused crawl spaces or basements can each be important steps to improve IAQ.[40] When ambient air contains smoke, dust, and allergens from extreme heat events, it is important that residences can be sealed off from external airborne irritants.

Oregon Housing and Community Services (OHCS) implements the WAP in Oregon.[41] In 2020, Oregon weatherized 161 units using WAP funding.[42] In theory, WAP funding could be used to install air quality monitoring devices or add central HVAC systems to

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ventilation rate and is likely to increase indoor air contaminant levels unless efficient ventilation systems are designed and installed). Also note, each state—with technical assistance from the U.S. Department of Energy (DOE)— implements its own residential efficiency codes derived from model codes promulgated by private standard-setting organizations. The most frequently used residential energy code is the International Energy Efficiency Code (IEEC). States have liberty to adopt part, all, or none of the model energy codes. Oregon's current energy code is adopted from the IEEC, 2018 edition. Office of Energy Efficiency & Renewable Energy, *Status of State Energy Code Adoption – Residential,* https://www.energycodes.gov/status/residential (last visited May 2, 2022).

[37] DEP'T OF ENERGY, DOE/EE-2124, WEATHERIZATION ASSISTANCE PROGRAM, (2021).

[38] OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY, *The History and Evolution of America's Weatherization Network,* DEP'T OF ENERGY, (Aug. 19, 2016) https://www.energy.gov/eere/articles/history-and-evolution-america-s-weatherization-network.

[39] *Id.* WAP was refunded through multiple acts of Congress and continues to work as a benefit at no cost to households at or below 200% of the federal poverty income level. *Id.*

[40] *See e.g.,* Schenck, *supra* note 1.

[41] OR. REV. STAT. § 458.505(2).

[42] OR. HOUSING AND COMM. SERVICES, WEATHERIZATION ANNUAL DATA REPORT (2020) https://www.oregon.gov/ohcs/energy-weatherization/Pages/energy-services-reports.aspx (under "2020 Reports," click "annual reports," download "Weatherization Annual Report) (Data used for 7-1-19 to 6-30-20). Oregon receives other weatherization funding through the federal Low Income Home Energy Assistance Program (LIHEAP), rate payer programs and state public purpose funds (Energy Conservation Helping Oregonians (ECHO)). OR. HOUSING AND COMM. SERVICES, LOW INCOME WEATHERIZATION ASSISTANCE PROGRAM, https://www.oregon.gov/ohcs/energy-weatherization/Documents/factsheets/factsheet-weatherization-assistance-program.pdf (last visited Sept 21, 2022).

residences to combat poor indoor air quality issues from extreme heat events.

D. Mitigations from other regulatory mechanisms

Federal regulation of IAQ in residences is not as stringently monitored as other environmental concerns, if at all. The Clean Air Act (CAA), administered through the EPA, sets federal standards (National Ambient Air Quality Standards or "NAAQS"[43]) for outdoor ambient air quality.[44] Utilizing cooperative federalism, the CAA induces states to propose and implement State Implementation Plans (SIP) to enforce CAA standards.[45] Unfortunately, no federal air quality standards specifically regulate indoor air quality standards within human occupancies and built structures. Oregon's Department of Environmental Quality (ODEQ) implements the state's CAA program. Again, absent IAQ standards, ODEQ generally acts as an educational online portal to resources and links for homeowners to improve their IAQ.[46]

The Oregon Residential Specialty Code ("ORSC") dictates residential building standards. Building standards are an indirect approach to filling the abyssal gap left by the lack IAQ standards in regulatory schemes. In fact, residential building standards can play a major role to ensure IAQ is at a healthy human range in the presence of extreme heat events by requiring proper technical building specifications. Guidance from federal agencies and private standard-setting organizations can inform a state's approach to IAQ. In Oregon, residential building codes are promulgated by the Department of

[43] NAAQS are upper limits of atmospheric concentration for six criteria pollutants (ozone, atmospheric particulate matter, lead, carbon monoxide, sulfur dioxide, and nitrogen oxides).
[44] Under the CAA, the EPA administrator identifies air pollutants that "may reasonably be anticipated to endanger public health and welfare" from "numerous or diverse mobile or stationary sources" and issues the criteria for those air pollutants that reflect the "latest scientific knowledge." 42 U.S.C. § 7408(a) & (b). In setting the standards to protect health and welfare for the public, the EPA must establish standards that are neither more nor less stringent than necessary and may not consider the costs of implementing standards. *See,* Whitman v. American Trucking Association, 531 U.S. 457, 465-476 (2001). Furthermore, "[a]ttainability and technological feasibility are not relevant considerations in the promulgation of national ambient air quality standards." American Petroleum Institute v. Costle, 655 F.2d 1176, 1185 (D.C. Cir. 1981).
[45] 42 U.S.C. § 7407(a) - (c).
[46] DEP'T OF ENV. QUALITY, *Residential Resources,* https://www.oregon.gov/deq/Residential/Pages/Indoor-Air.aspx (last visited May 2, 2022).

Consumer and Business Services (DCBS),[47] Building Codes Division (BCD).

The Oregon Residential Specialty Code (ORSC) is the source of residential building codes for energy efficiency standards,[48] heating and cooling equipment standards,[49] radon control methods,[50] and venting methods.[51] Oregon's residential building code, the Oregon Residential Specialty Code (ORSC), borrows from the International Fire Code (IFC) and International Residential Code (IRC) from the ICC.[52]Additionally, ORSC is ripe with construction requirements for walls, roofs, floors, foundations, and duct/exhaust systems. Taken together, each of these regulations has a part to play in maintaining residential IAQ.

III. ANALYSIS

Due to the lack of a federal regulatory scheme for IAQ, the responsibility to protect indoor air quality against extreme heat events falls on the states to weigh different interests and set standards that they deem important for their residents. Because environmental stressors are felt differently across the United States, state-based regulation is a logical way to navigate geographic-specific environmental concerns like the extreme heat events that Oregon, and the Greater Pacific Northwest, face.

A. Considering a regulatory framework for IAQ PM regulations in Oregon – Voluntary versus involuntary indoor air quality approaches

Voluntary IAQ monitoring and testing raises broad questions about the best monitoring approach for residences during extreme heat events. A voluntary approach allows residents suspecting their IAQ has been affected by extreme heat to choose how to address their individualized concerns, whether by changing filters on their central

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[47] OR. REV. STAT. § 455.020 (1) and (2) (2021). BCD-adopted codes have preemption over municipal ordinances. OR. REV. STAT § 455.040 (2021).
[48] *See e.g.* OR. RES. SPECIALTY CODE ch. 11.
[49] *See e.g.* OR. RES. SPECIALTY CODE ch.14.
[50] *See e.g.* OR. RES. SPECIALTY CODE app. F.
[51] *See e.g.* OR. RES. SPECIALTY CODE app. N.
[52] OR. RES. SPECIALTY CODE R.101.2 (2021).

HVAC system; weatherizing an older residence; pursuing at-home air quality testing or hiring an air quality testing company; or purchasing a portable HEPA filtration device. Such a system implemented by public assistance is already provided partially via the Healthy Homes Program, outlined below in Section II. Under this approach, residents can seek out public assistance when they have been affected by air quality issues exacerbated by extreme heat events.

A downside of voluntary IAQ monitoring is that its optional nature will likely not spur action from players like landlords and developers (those who would foot the bill for their residents' benefit) or residents with little awareness of PM's health effects. The voluntary approach raises additional equity issues about who has the financial means and ability to conduct testing, and generally represents the current state of Oregon's IAQ monitoring: testing is available, but only through private companies and only if one chooses to voluntarily request it.[53]

An involuntary enforcement monitoring approach to IAQ for private residences presents more administrative questions than a voluntary approach.[54] Some of these questions are:

(1) Which state agency would set indoor air quality standards?
(2) What policy metric would be used to set indoor air quality standards?

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[53] An example of a voluntary standard setting approach was is Oregon's Radon Control Methods under ORSC Appendix F to decrease Radon levels in newly built residences. S. 1025, 75th Leg. Assemb., Sp. Sess. (2010). To do so, Appendix F set structural requirements for newly constructed residences in seven Oregon counties. *Id.* Appendix F cites EPA's standard for radon as unhealthy if radon levels exceed 4.0 picocuries per liter (pCi/L). OR. HEALTH AUTH., *How to Test a Home for Radon,* https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/HEALTHYNEIGHBORHOODS/RADONGAS/Pages/testing.aspx (last visited May 2, 2022); EPA, *What is EPA's Action Level for Radon and What Does it Mean?* https://www.epa.gov/radon/what-epas-action-level-radon-and-what-does-it-mean (last visited Sept. 21, 2022).

[54] There are also legal considerations to an enforcement approach of residential IAQ standards. Property is a constitutionally protected interest, both by substantive due process and the Fifth Amendment Takings Clause. Government regulation within the home is generally discouraged and unwelcome and may be met with resistance. Additionally, at common law, enforcing IAQ standards within the home could be seen as a private nuisance, because it may unreasonably interfere with the rights of the property owner to maintain their dwelling as they see fit, regardless of the human health consequences. Another legal issue arises if an enforcement plan were to be enacted: liability and severability. Theoretically, responsible parties to a residential indoor air quality administrative case could range from product manufacturers to developers to landlords to property managers to property owners to renters. Each of these parties would be correct to point blame to poor IAQ as a general result of external ambient air quality or improper building sealing, which could in turn implicate private emitters and state agencies.

(3) Should indoor air quality be inspected after complaint/air quality incidents or metered daily?
(4) Who has liability for violating indoor air quality standards?
(5) What is an appropriate penalty or remedy for nonconforming property owners?

As is often the case, a multi-faceted policy approach, drawing from both voluntarily and mandated mechanisms, is a stronger option for improving IAQ during extreme heat events. Long-term, upstream tools like building codes hold contractors and developers accountable to construct new properties to uniform technical standards and act as both direct and latent IAQ mitigations and protections. Voluntary state funding is available through WAP and the new Healthy Homes Program. What's missing in Oregon's equation is an IAQ monitoring scheme that mandates air quality protections and will incentivize improving residential air quality for tenants that can overcome the hurdles of pre-existing vulnerabilities (including non-ownership and indigence) and implementation feasibility which has precluded specific tenants from improving their residence's physical protections against poor ambient air quality.

B. Oregon's Current IAQ Approach: Partial Preventative Measures through Voluntary IAQ Monitoring

In 2021, Oregon passed HB 2842, creating the Healthy Homes Repair Fund (HHRF). [55] HHRF assists a wide net of homeowners within Oregon to update their residences via grants to prepare for the upcoming climate change events.[56] Any residence, meaning a single-family home, residential trailer, mobile home, condominium unit, or unit within multifamily housing, that contains one or more individuals of low income[57] is eligible.[58] Established under the purview of the Oregon Health Authority (OHA), the program provides grants to eligible entities that provide financial assistance to low-income households to "repair and rehabilitate" their homes or landlords to repair and rehabilitate dwelling units.[59] The HHRF provides $10

[55] H.R. 2842(1)(e), 81st Leg Assemb., Reg. Sess., (2021).
[56] *Id.*
[57] *Id.* ("'low income' means a household having an income equal to or below 80 percent of the area median family income as determined by the authority")
[58] *Id.*
[59] *Id.*

million to "improve the health, safety, and energy efficiency of housing stock for low-income Oregonians.[60] These grants can be used for a variety of home repairs, including heating and cooling systems, fire hardening, and measures to improve indoor air quality like duct sealing, mold abatement, and air purifiers."[61] Repairs can include energy efficiency improvements, health and safety upgrades including radon, lead or mold abatement, installation of smoke filtration or air purification systems, structural improvements, seismic upgrades or other repairs."[62] Under the definition for potential rehabilitation, the grant is able to cover installation of a "smoke filtration system," defined as a "residential air filtration system that meets minimum efficiency standards, as determined by the authority, for the removal of particulates and other harmful substances generated by wildfires."[63]

As explained above, the HHRF is a new option for homeowners *and* landlords to use grant money to rehabilitate residential buildings and add new ventilation systems for extreme heat events. However, the program places the onus on the individual to apply for funding, which does not necessarily remove barriers for those who need indoor air quality monitoring the most. Additionally, absent encouragement by another mechanism, landlords and developers may choose not to apply to the HHRF to improve the conditions of their residents' living spaces.

C. Policy Recommendations for a state level IAQ PM regulatory scheme in Oregon

1. Authorize OHA to set IAQ PM standards for Landlord-Tenant Residences

Although Oregon funds protective air quality upgrades for residents' homes and apartments through HHRF, there is no explicit level of IAQ PM that is deemed unhealthy or hazardous. This effectively means there is no target which property owners must shoot

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[60] *Id.*
[61] *Oregon Passes Healthy Homes Repair Fund (HB 2842) Amidst Record Heatwave* (June 26, 2021) https://cleanenergyoregon.org/en/news/oregon-healthy-homes-passes.
[62] *Id.*
[63] H.R. 2842(1)(iii), 81st Leg Assemb., Reg. Sess., (2021). For more information on household grant applications, visit: https://www.fairshotoregon.org/healthyhomes.

for when it comes to air quality improvements or monitoring. Standardizing IAQ PM monitoring begins with standard-setting.

Oregon Health Authority (OHA) is the appropriate agency to set the IAQ PM standard because it has statutory authority to directly supervise "all matters relating to the preservation of life and health for the people of the state."[64] Additionally, OHA has specific authority to regulate indoor air quality via ORS 433.521 if it so wishes and to establish indoor air quality standards for IAQ.[65] OHA's statutory authority expressly includes "Particulate Matter."[66]

Research from the EPA ORD, or research conducted via Oregon's DEQ, is a starting point. The standards set should be health-based standards because PM exposure has the potential to lead to serious cancers and long-term respiratory illness. There are already multi-level health standards set regarding PM in the CAA's NAAQS, which recognize the risks associated with different sizes of PM. OHA should enlist researchers to determine the maximum level of PM exposure that would be unlikely to impact human health during extreme heat events. To increase the viability of the monitoring program, OHA could factor in economic and technological feasibility to standard-setting to ensure that landlords can in fact maintain healthy IAQ PM levels during extreme heat events.

2. Facilitate a Standardized Testing Accreditation program for IAQ PM sampling through ORS 468A.775.

A technological area that needs to be explored further is the ability to conduct IAQ PM sampling by non-expert professionals or residents themselves. Currently, local private companies offer residential air quality sampling.[67] Samples are then sent to laboratories to determine the detailed constituents of the particulate matter. There are personal monitoring devices available on the market (ranging from $100-$300 dollars[68]) that can detect PM2.5, but do not offer detailed analyses of PM constituents like lab sampling does. This is a challenge because PM can come from a variety of internal sources – pets, plants, and humans included![69] Using personal monitoring devices may be a

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[64] OR. REV. STAT. § 431.110(1) (2021).
[65] OR. REV. STAT. § 433.521(2)(a).
[66] *Id.*
[67] *See e.g.* POWELL & SONS, https://powellandsons.com (last visited May 2, 2022).
[68] *See* AWAIR ELEMENT, https://www.getawair.com/products/element (last visited May 2, 2022).
[69] Schenck *supra* note 1, at 5.

useful litmus test for residents to maintain healthy indoor air during extreme heat events, but so far, these devices cannot be used with any certainty to enforce PM standards from a regulatory perspective.

There is evidence of a statutorily-created, voluntary indoor air accreditation program via ODEQ's Environmental Quality Commission (EQC), which would standardize the practice of indoor air quality sampling services and create a voluntary contractor certification for contractors who "provide remedial action for residential indoor air pollution."[70] ORS 468A.775 is flagged by a note that voluntary accreditation programs were not added by legislative action and are merely editorial. The legislative note raises the question of whether ODEQ EQC is required to promulgate rules for an accreditation program or is only delegated authority to create such a program; to date, no information on such a program's existence exists within ODEQ.

Another issue to address is the testing and sampling parameters for PM. PM comes from many types of sources, and sampling companies can test for type of particulate, size of particulate, state (solid or liquid) of particulate, and the amount located within an indoor area.[71] ODEQ EQC's statutory authority should be expanded and a program should be developed by ODEQ EQC to establish an accreditation program with services that are able to test for all parameters, because all would be required to identify indoor PM caused by extreme heat events. This would ensure that residences are tested appropriately by using ODEQ EQC-accredited sampling companies.[72]

3. Authorize OHCS to Promulgate Testing Schedules for Landlord-Tenant Residences Receiving Assistance from OHCS.

Oregon Housing and Community Services (OHCS) has authority to perform compliance monitoring and assess a civil penalty

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[70] OR REV. STAT. § 468A.775(1) (2021) ("The Environmental Quality Commission shall establish a voluntary accreditation program for those providing indoor air quality sampling services or ventilation system evaluations for public areas, office workplaces or private residences. Provisions shall be made to accept accreditation of other state programs if they are comparable with the accreditation program established under this section.").

[71] EPA, *Indoor Particulate Matter,* https://www.epa.gov/indoor-air-quality-iaq/indoor-particulate-matter (last visited Sept. 22, 2022).

[72] An alternative option to mandating sampling and testing services would be to create a new public works program that offers IAQ PM testing or distributes free monitoring devices. This would require large amounts of funding on behalf of ODEQ EQC or OHA to produce, but it may be necessary as climate change continues to exacerbate indoor air quality. The Energy Trust of Oregon could be a stakeholder in a policy approach that distributes IAQ PM monitoring devices for residences.

on any project receiving its department's assistance.[73] As such, OHCS and OHA would need to consider if landlords should be required to initiate inspections for their buildings, or if OHCS could offer IAQ PM inspections when certain extreme heat events are recorded by county. As mentioned *supra*, either option would yield a different amount of public funding and would drastically change the perception of the enforcement scheme.

Another element of sampling that should be considered is how often and at what time of the year landlords will be required to sample for indoor PM. For Oregon, wetter seasons typically increase indoor PM due to indoor mold growth.[74] Private air quality inspectors in Oregon cite this as a general reason why Oregon homeowners ask for air quality inspections.[75] While climate change will affect all seasons and increase particulate matter generally, this paper focuses on policies that will alleviate the effects of extreme heat events on IAQ PM. Thus, OHCS could align inspections and testing timelines with that of their new recording requirements enacted via Senate Bill 1536 (SB 1536), which requires OHCS to record the dates of extreme heat events by county.[76] SB 1536 data could be used as the trigger baseline to employ mandatory IAQ PM inspections after an extreme heat event. Inspection would likely need to be conducted 1-2 weeks following poor initial ambient air quality readings in the county, before IAQ PM dissipates back into the environment. The short response timeline would be a constraint on inspections and the availability of sampling resources (e.g., sampling kits, sampling companies, communications between landlords and public agencies) for an effective monitoring response to occur.

4. Authorize OHCS to Enforce a PM Monitoring Scheme.

Everyone's favorite[77] part of civil enforcement is the stick—penalties and fines. OHCS would need to determine what type of enforcement to employ for non-conforming ORS Chapter 90 landlords, as well as remediation strategies to avoid residents' exposure to PM during extreme heat events. The purpose of the civil enforcement scheme should be to disincentivize poor air quality in landlord-owned residences during extreme heat events as well as protect vulnerable

[73] OAR 813-005-0040; OR. REV STAT. § 317.097; OR. REV. STAT. § 456.55(4).
[74] Telephone Inquiry, Caliper Home Inspections, (Feb. 10, 2022).
[75] *Id.*
[76] S. 1536 81st Leg. Assemb., Reg. Sess. (2022).
[77] Dependent on your proclivity for remediation-driven punishment theories.

residents' health. A fine could be based off of the amount above the baseline standard of PM that has entered the building as a result of extreme heat events, as documented during an ODEQ-EQC mandated inspection. Any penalty amount should be costly enough to deter noncompliance.

As history tells us, any type of enforcement scheme would have many opponents. It may be more palatable to couple such a program with a proverbial "carrot" for landlords to maintain MERV 13-16 HVAC systems or supply portable HEPA filtration devices during extreme heat events. Such systems could be implemented using the Healthy Homes Repair fund and WAP funding. Alternatively, the "HEPA carrot" could instead be the basis for the appropriate amount of civil penalty—if in noncompliance with the PM standard, the landlord must pay the total amount required for their units to have a working HEPA filtration device during extreme heat events.

IV. CONCLUSION

In the face of future extreme heat events, Oregon needs additional protections for vulnerable residential populations, especially those living in Tenant-Landlord ORS Chapter 90 residences that will be greatly impacted by increased PM due to extreme heat events. While Oregon has pursued voluntary IAQ monitoring and mitigation through the HHRF and WAP funding programs, more policy-focused efforts should be undertaken to promulgate regulations setting IAQ PM standards, to implement testing or monitoring schemes, and to enforce regulations requiring landlords conform to adequate air quality standards when extreme heat events render residences vulnerable to increases in PM and other airborne pollutants. Absent a protective policy scheme, Oregon's most vulnerable people will continue to bear the brunt of indoor air quality issues at home. In a society where proactive policymaking is shoved off the legislative table as bureaucratic overkill, those who are systemically hurt by a lack of protections remain exposed to deleterious health effects and reactive decision-making. Given the predictive models suggesting that Oregon is far from ridding itself of wildfires and heatwaves exacerbated by global warming,[78] policymaking that protects our communities from

[78]*See e.g.,* S.W. Taylor, *et. al, Wildfire Prediction to Inform Fire management: Statistical Science Challenges,* 28 Stat. Sci. No. 4, 586-615 (2013), DOI: 10.1214/13-STS451.

the health problems associated with extreme heat events and particulate matter exposure is a focused recommendation, deserving of immediate action and implementation.